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# SCIENTIFIC AMERICAN SUPPLEMENT

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GAVERY SC

# SCIENTIFIC AMERICAN SUPPLEMENT, No. 940


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## RESCUING AN ELEPHANT CALF FROM A PITFALL.

By PARKER GILLMORE.

BEFORE firearms were introduced into the interior of tropical South Africa, the greater part of the ivory exported from that country was obtained from elephants captured in pitfalls, in the construction of which the natives displayed great ingenuity. This talent was the result of their intimate knowledge of the habits of all wild animals that frequented the neighborhood in which they resided. As our youths go to school to fit themselves for their future avocations of life, so the Kaffir, Zulu or Bechuana youngsters go out on the veldt to study practical natural history, that they may become mighty hunters; for, when distinguished in this science, they are rapidly promoted to the rank of warriors, and then they have a voice in the councils of their respective tribes, and are permitted to marry, with other equally substantial advantages.

The pitfall that is constructed for the capture of elephants is a hole about ten or twelve feet long, five feet wide, and about ten or twelve feet deep. It is in shape from the surface of the ground to the bottom exactly like the letter V. This formation is adopted so that the unfortunate captive can obtain no footing for his large feet at the bottom; otherwise he would be able to rear on end and regain his liberty. For the companions of a mature old bull to lift him out of his perilous position would be a difficult task, but in the case of a half-grown youngst r the matter is comparatively simple. One of the herd entwines her trunk with the prisoner's, while another places her* proboscis under the captive's forequarters, when, with a strong heave and a heave together, liberation is rapidly accomplished.

The most difficult part of pit making is covering it over so that its upper surface exactly resembles the adjoining ground. otherwise the wary animals would take alarm and change their route, or go round them. To accomplish this, a layer of the slimmest canes are placed over the mouth of the pit; this, in turn, is covered with coarse veldt grass, the whole being top-dressed with sand, in which various common weeds or shrubs are planted. This labor being satisfactorily performed, the whole surface of the trap is abundantly watered, so that no taint of human presence can be detected, for the sense of smell is developed to an extraordinary degree in these mammoth beasts. Paths that elephants select when going to water, or the vicinity of favorable fruit trees—such as the meruleys—are generally the places selected for the position of the pitfall.

It is currently said among the native hunters that if once an elephant has escaped from one of these traps, no skill or artifice will ever induce it to enter another. This is not improbably true, for it is well known that they possess wonderful memories, and that after the lapse of years they will at once recognize a person who has treated them with cruelty or even unkindness. A young elephant that I possessed was burnt on the trunk by a Kaffir blacksmith. Many months afterward I returned to the neighborhood where this wanton act was performed to have some repairs done to my wagons. My pet followed me to the forge. I found the same man employed in his trade. While explaining my wants to him the youngster gave him a blow with his trunk that sent the man reeling for several yards.

The scene depicted in the sketch was witnessed by a Griqua who hunted for me. After listening to the "boy's" story, I visited the pitfall, and from close, practical examination of the place I am convinced that my informant had in no way exaggerated what he had seen.

If the chief of a country in which you are hunting is friendly to you, he will order all the pitfalls to be opened. When this has not been attended to, serious accidents have frequently happened to sportsmen.—*London Graphic.*

FEMALE ELEPHANTS RESCUING A YOUNGSTER FROM A PITFALL.

* The young are always with the females, who have only short tusks.

## ANTARCTIC EXPLORATION.

AT a recent meeting of the Royal Geographical Society, London, Dr. John Murray, of the Challenger expedition, read a paper on "The Renewal of Antarctic Exploration."

The meeting was really the initiation of a movement for the purpose of inducing government to aid in the equipment of an Antarctic expedition.

Dr. Murray, after sketching the history of Antarctic explorations and of the notions which prevailed as to the nature of the South Polar region from the earliest time down to the present day, showed that,

while the immense southern coutinent of past ages has been vastly diminished by increased knowledge, the probability is that around the South Pole there is a land area of about 4,000,000 square miles. The actual state of our knowledge of the region, he said, was extremely meager, and until that knowledge was greatly increased there were many problems in science that must remain unsolved. Until we had a complete and continued series of observations in the Antarctic area the meteorology of the globe could not be understood. Important problems in geology, in biology, iu physics, in oceanography, demanded the renewal of research on an adequate scale iu the South Polar area. As had been the case in the past, the solution of these problems by scientific investigation could not but have important practical results for humanity. Within the past few months he had been in communication with geographers and scientific men in many parts of the world, and there was complete unanimity as to the desirability, nay, necessity, for South Polar exploration, and wonder was expressed that an expedition had not long since been fitted out to undertake investigations which, it was admitted on all sides, would be of the greatest value in the progress of so many branches of natural knowledge. To determine the nature and extent of the Antarctic continent; to penetrate into the interior; to ascertain the depth and nature of the ice cap; to observe the character of the underlying rocks and their fossils; to take magnetical and meteorological observations both at sea and on land; to observe the temperature of the ocean at all depths and seasons of the year; to take pendulum observations on land, and possibly also at great depths in the ocean; to bore through the deposits on the floor of the ocean at certain points to ascertain the condition of the deeper layers; to sound, trawl, and dredge, and study the character and distribution of marine organisms—all this should be the work of a modern Antarctic expedition. For the more definite determination of the distribution of land and water on our planet; for the solution of many problems concerning the ice age; for the better determination of the internal constitution and superficial form of the earth; for a more complete knowledge of the laws which govern the motions of the atmosphere and hydrosphere; for more trustworthy indications as to the origin of terrestrial and marine plants and animals—all these observations were earnestly demanded by the science of our day. A few months ago he bade good-by to Nansen, and said he expected within two years to welcome him on his return from the Arctic; but he expressed some doubt whether he should again see the Fram. "I think you are wrong," was the reply; "I believe you will welcome me on this very deck, and after my return from the Arctic, I will go to the South Pole, and then my life's work will be finished." (Cheers.) That was a spirit we must all admire. We felt it deserved, and was most likely to command, success. All honor to those who ventured into the far north or south with slender resources and brought back with them a burden of new observations. A dash at the South Pole was not what he now advocated, nor did he believe that was what British science at the present time desired. It demanded rather a steady, continuous, laborious, and systematic exploration of the whole southern region with all the appliances of modern investigators. This exploration should be undertaken by the Royal Navy. (Cheers.) Two ships not exceeding 1,000 tons should, it seemed to him, be fitted out for a whole commission, so as to extend over three summers and two winters. Early in the first season a wintering party of about ten men should be landed somewhere to the south of Cape Horn, probably about Bismarck Strait, at Graham's Land. The expedition should then proceed to Victoria Land, where a second similar party should winter, probably in Macmurdo Bay, near Mount Erebus. The ships should not be frozen in, but should return to the north, conducting observations of various kinds toward the outer margins of the ice. After the needful rest and outfit, the position of the ice and the temperature of the ocean should be observed in the early spring, and later the wintering parties should be communicated with, and, if necessary, re-enforced with men and supplies for another winter. During the second winter the deep sea observations should be continued to the north, and in the third season the wintering parties should be picked up, and the expedition return to England. The wintering parties might largely be composed of civilians, and one or two civilians might be attached to each ship; this plan worked admirably during the Challenger expedition. What, it might be asked, would be the advantages to trade and commerce of such an expedition? It must be confessed that no definite or very encouraging answer could be given. We knew of no extensive fisheries in these regions. For a long time seal and sea elephant fisheries had been carried on about the islands of the Southern Ocean, but we had no indication of large herds or rookeries within the Antarctic Circle. A whale fishery was at one time carried on in the neighborhood of Kerguelen, but this right whale, if distinct from *Balæna Australis*, appeared to have become nearly if not quite extinct. Some expressions of Ross would lead one to suppose that a whale corresponding to the Greenland right whale inhabited the seas within the Antarctic ice, but we had no definite knowledge of the existence of such a species. Although whales, like the finner, were undoubtedly abundant, they did not repay capture, and though penguins exist in countless numbers, they were at present of no commercial value. Deposits of guano were not likely to be of any great extent, but it was impossible to speak with confidence on a matter like this—the unexpected might quite well happen in the way of discovery. With great confidence, however, it might be stated that the results of a well-organized expedition would be of capital importance to British science. We were often told how much more foreign governments did for science than our own. It was asserted that we were being outstripped by foreigners in the cultivation of almost all departments of scientific work. But in the practical study of all that concerned the ocean this was certainly not the case; we had to acknowledge no superiors, nor even equals, in this branch of investigation, and if we were a wise and progressive people, British science would always lead the way in this direction. This country had frequently sent forth expeditions, the primary object of which was the acquisition of new knowledge—such were the expeditions of Cook, Ross, and the Challenger; and the nation as a whole had always approved such action, and had been proud of the results, although they yielded no immediate return. (Cheers.) Should it be said that there was to be no successor to these great expeditions? The prestige of the navy did not alone consist in its powers of defense and attack. It had in times of peace made glorious conquests over the powers of nature, and it was asked that the officers and men of the present generation should be afforded the same opportunities as their predecessors. (Cheers.) A preliminary responsibility rested on the geographers and representatives of science in this country. It was necessary to show that we had clear ideas as to what was wanted, that a good workable scheme could be drawn up. When this had been done, it should be presented to the government with the unanimous voice of all our scientific corporations. He had little doubt that a minister would then be found sufficiently alive to the spirit of the times and with sufficent courage to add a few thousand pounds to the navy vote for three successive years, in order to carry through an undertaking worthy of the maritime position and the scientific reputation of this great empire. (Cheers.)

[Continued from SUPPLEMENT, No. 939, page 15006.]

## THE MOON'S FACE—A STUDY OF THE ORIGIN OF ITS FEATURES.

By G. K. GILBERT.

*Sculpture.*—The rims of certain craters are traversed by grooves or furrows, which arrest attention as exceptions to the general configuration. In the same neighborhood such furrows exhibit parallelism of direction. Similar furrows appear on tracts between craters, and are there associated with ridges of the same trend, some of which seem to have been added to the surface. Elsewhere groups of hills have oval forms with smooth contours and parallel axes, closely resembling the glacial deposits known as drumlins, but on a much larger scale. Tracing out these sculptured areas and platting the trend lines on a chart of the moon, I was soon able to recognize a system in their arrangement, and this led to the detection of fainter evidences of sculpture in yet other tracts. The trend lines converge toward a point near the middle of the plain called Mare Imbrium although none of them enter that plain.

Associated with the sculpture lines is a peculiar soft-

FIG. 14.—Trends of lunar sculpture. General sculpture is represented by shading; great furrows by heavy lines. Irregular lines show crests of uplands surrounding M. Imbrium.

ening of the minute surface configuration, as though a layer of semi-liquid matter had been overspread, and such I believe to be the fact; the deposit has obliterated the smaller craters and partially filled some of the larger. These and allied facts, taken together, indicate that a collision of exceptional importance occurred in the Mare Imbrium, and that one of its results was the violent dispersion in all directions of a deluge of material—solid, pasty, and liquid. Toward the southwest the deluge reached nearly the crater Theophilus, a distance of 900 or 1,000 miles, and southward it extended nearly to the latitude of Thebit. Northward and northeastward it probably extended to the limb. Westward it passed beyond Posidonius, and toward the east and southeast its traces are lost in the Oceanus Procellarum.

Its more liquid portion gathered on the lowlands, giving rise to several maria and minor plains. The fact has been recognized by various students, notably by Green* and Meydenbauer,† that many of the lunar plains are due to floods of molten material overspreading the low-lying tracts and burying the pre-existent irregularities of surface. At various points in such plains, and especially at their margins, crescentic hills project above them, recognized as portions of crater rims; and elsewhere the plains are divided by systems of cracks whose arrangement betrays the distribution of underlying ridges. The plains most closely associated with the sculpture system and the supposed viscous deposit are the Sinus Roris, Mare Frigoris, Lacus Mortis, Lacus Somniorum, Palus Nebularum, Mare Tranquilitatis, Mare Vaporum, Sinus Medii, Sinus Estuum, and Mare Nubium. The Oceanus Procellarum may have been created at the same time or may have been merely modified by this flood. The Mare Serenitatis, whose sharp outlines and circular form mark it as an old crater, doubtless received a new surface.

As to the precise nature of this catastrophe I am in doubt. Its focus lies within the great crater rim of the Caucasus, Apennine, and Carpathian ranges, but is not concentric with that rim, and it is not surrounded by a rim of its own. The lofty plateau lying north of the Mare Imbrium, although presenting a steep face toward the mare and a long slope in the opposite direction, has not the simple contour of a crater wall, but is variously notched. By considering the extent and probable thickness of the various deposits from the flood, it has been estimated that its volume may have equaled a sphere 80 or 100 miles in diameter, and there is perhaps no occasion for surprise that the results of the collision of a body of such magnitude were exceptional in character as well as extent.

So far as I am aware, these features of sculpture have not previously been recognized.* It is therefore of special importance that my observations be verified by those of others, and to this end the general statement will be supplemented by the enumeration of enough particulars to serve as a clew to the recognition of the novel phenomena. The general distribution of the sculpture, comprising the districts in which it is faintly exhibited as well as those in which it is conspicuous, is indicated in Fig. 14, where the shaded areas represent sculpture districts and the direction of the fine parallel lines indicates the trend of the sculpture. The interspaces between shaded areas are largely occupied by maria and other plains on which no sculpture appears.

The boldest carving is seen on the Apennines, the crest line of which is cut into battlements. From the hollows between battlements, rude grooves follow radially down the southern slope to its base. A similar sculpture appears on the Caucasus, but the range is traversed obliquely, from E. S. E. to W. N. W. The sculpture features of the Carpathians are less conspicuous, but immediately south of them is a tract occupied by drumlin-like hills, the axes of which point toward the Imbrian plain. The broad isthmus between the Mare Vaporum and the Mare Serenitatis is so thoroughly sculptured that most of its features exhibit parallel trend in a south westerly direction. The great crater of Julius Cæsar has lost most of its southern wall, and its valley is filled to the level of the remnant of rim on that side. Boscovich is barely to be recognized as a crater, and whatever other craters may have antedated the flood are defaced beyond recognition. Manilius, Menelaus, and a few others are of more recent date, and their clean-cut features stand in striking contrast to the general ruin.

Similar features with slightly different trend characterize the plain for 200 miles south of Julius Cæsar. The rims of Hipparchus, Albategnius, Ptolemy, and Alphonsus are all notched by grooves trending toward the Mare Imbrium, and some of these grooves can be traced to the vicinity of the crater Lalande. The rims of Parry, Bonpland, and Guerike, jutting islandwise from the Mare Nubium, are similarly notched, the trend here coinciding almost precisely with the meridian.

Through the entire region lying between the Mare Nubium and the Maria Serenitatis and Tranquilitatis sculpture and the associated veneering have so modified the surface that there is no difficulty in discriminating the craters of later date from those of earlier. The whole topography may be classified as antediluvial and postdiluvial. The only small craters are those of the later series, as the older have been filled and buried. Craters of the older series have lost in accentuation not only through the paring of their rims, but also through the partial filling of their valleys, and their rims no longer exhbit the fine details of inner terracing and outer furrowing. Compare in these respects Hipparchus, Albategnius, and Alphonsus of the old regime with Alpetragius, Horrox, Theophilus, and Copernicus of the new.

Adjoining this district on the south and extending thence to the south pole is a broad area, known as the honeycomb district, to which the flood did not extend and with which the characters of the flooded district may be compared. In the honeycomb district distinctions of age may, indeed, be recognized, but there is gradation instead of sharp demarkation between old and new. Those parts of the surface which have been longest exempt from the downfall of large bodies are profusely pitted with minor craters, and it is these which dim the outlines of larger formations of ancient date.‡

Thus, by the outrush from the Mare Imbrium were introduced the elements necessary to a broad classification of the lunar surface. A part was buried by liquid matter whose congelation produced smooth plains. Another part was overrun by a flood of solid and pasty matter which sculptured and disguised its former details. The remainder was untouched, and probably represents the general condition of the surface previous to the Imbrian event.

*Furrows.*—In strong contrast with all other features of the moon's surface are a series of gigantic furrows. In general direction they are remarkably straight, but their sides and bottoms, with a single exception, are jagged, abounding in acute salients and re-entrants. If one thinks only of their apparent size instead of their real magnitude as he examines them through the telescope, he is reminded of the rude grooves sometimes seen on glaciated surfaces where the corner of a hard bowlder, dragged forward by the ice, has plowed its way through a brittle rock. Despite the enormous disparity in size—a disparity no less than that of a mountain to a molehill—I believe that this resemblance is more than accidental, and that the lunar furrows were really formed by the forceful movement of a hard body; but the graving tool in this case, instead of being slowly pushed forward by a matrix of ice, moved with high velocity and was controlled only by its own inertia. It was my first idea that the furrows are the tracks left by solid moonlets whose orbits at the instant of collision were nearly tangent to the surface of the moon, and for some of them I have still no better explanation to suggest; but when they came to be platted on a chart of the moon's face it was found that more than half of them accord in direction with the trend lines of the Imbrian outrush, a relation which can be seen in Fig. 14, where they are represented by heavy lines. It thus appears possible, if not probable, that they were produced simultaneously with the Imbrian deluge, and the implication of power is thereby rendered even more impressive. What must have been the violence of a collision whose scattered fragments, after a trajectory of more than a thousand miles, scored valleys comparable in magnitude with the Grand Canyon of the Colorado!

So far as I am aware, but four of these furrows have been previously recorded, and only two are well known, the valley near Rheita and the valley of the Alps, and

* E. N. Green: Jour. Brit. Ast. Ass., April, 1891, p. 379.

† A. Meydenbauer: Sirius, February, 1882.

* Parallelism has been noted by Beer and Madler in the tract south of M. Serenitatis (Der Mond., p. 250), and by Neison south of the Carpathians (The Moon, p. 309), but no reference is made to sculpture.

I therefore invite the attention of observers to the localities indicated by the following descriptions. Beer and Madler, who set fortb the character of the Rheita valley at length and with great clearness, state that it is 187 miles long and from 10 to 25 miles broad and has a maximum depth of more than 11,000 feet.* Its general course runs from the eastern tangent of the crater Rheita southwestward to the northern margin of the crater Rheita *d*. Not far from its southwestern extremity starts a smaller valley with a somewhat more southerly course. Parallel to this latter valley and somewhat to the southeast are a number of minor grooves which give a striated appearance to an area between Metius and Vlacq. One of these can be traced northeastward to a point just west of tbe crater Piccolomini. Although unquestionably a unit, it is not continuous, but appears here and there as though the projectile grazed only the higher uplands, and it is locally blotted out by the craters Metius and Fabricius, which are of more recent date. Its total length is 450 miles. Another of the same system appears to the northwest of the crater Furnerius. More conspicuous than these and more westerly in trend is a groove seen first at the southern tangent of Borda and traced for 500 miles west-southwest across tbe southern part of Snellius and past the soutbern margins of Haze and Adams. Its width is in general about 10 miles, but width and depth are irregular, and it leaps a number of valleys, including the bed of Snellius. Beer and Madler† record a part of it just west of Snellius, but apparently saw no other part. West of the Mare Nectaris and following the eastern base of the Pyrenees mountains is a trough which should probably be classed with tbe furrow system, but I have not seen it with the illumination suitable for the determination of its details. In length and width it resembles the Rheita valley and it trends nearly with the meridian. It is crossed obliquely by a narrower groove trending approximately with tbe Imbrian system and intersecting the crater Capella. This is partly represented on Schmidt's map. My notes indicate also a very old furrow trending southeastward from a point about 175 miles east from Clavius, but its precise position was not determined. Tbe straight valley traversing the lunar Alps, better known tban any of the others, is likewise exceptional in character. Its sides are no less irregular than those of the other furrows and are even more precipitous, but its bottom is smooth, so that it constitutes a comparatively narrow, flat-bottomed defile, traversing the plateau from side to side. Neison gives its length as 83 miles and its breadth as ranging from 6 to 3½ miles, but at a point near its southern end it is still narrower. Its maximum depth is more than 10,000 feet. Its trend coincides with that of tbe Imbrian sculpture in its vicinity, and it thus helps to unite the furrow group of the western district witb the great sculpture system. The flatness of its bottom is readily explained as a result of partial flooding, but its constriction is less easily explained.‡

*Wargentin.*—One of the most striking anomalies of the moon's face is the plateau Wargentin. It is a smooth, circular table 54 miles wide, standing several thousand feet above its base and bearing a low parapet about the greater part of its edge. It is readily recognized as a crater tbat has been filled by molten rock to the level of the lowest point of its lofty rim, and the determination of its mode of filling is a problem that has occupied the attention of all selenologists. A solution consonant with the moonlet theory is suggested by the Imbrian deluge. As already noted, the crater of Julius Cæsar is filled as high as the breach through its southwestern rim. The filling, however, was not even, as the added material was not sufficiently fluent to acquire a level surface. Five hundred miles away, in a district where the deluge was more liquid, the crater of Posidonius shows a level floor at the height of the lowest point of the rim. It happens that the walls of Posidonius are very uneven, and tbat their lowest pass is only a little bigher than the neighboring Mare Serenitatis. Its floor, therefore, does not attract attention as an elevated plateau, but the relation of floor to rim is essentially the same as in Wargentin, and community of origin is a natural inference. Further study will be required to determine the source of the Wargentin accession, but clews are not wanting, for the neighborhood abounds in evidence of flooding. Close to Wargentin's western base lie three craters, of which the nearest, Phocylides *b*, is partly filled and Phocylides *c* is almost completely filled, though the largest, Phocylides, is empty. To the nortbwest of these and to the south of Mare Humorum is a broad tract characterized by much filling of craters and by the obliteration of minute craters. It has the general aspect of the Imbrian region, but I have not ventured to include it in the Imbrian chart, as it is separated by nearly 200 miles of the Nubian plain from the nearest district distinctly sculptured, If it did derive its overwash from tbe Mare Imbrium, then that flood extended in this direction more than 1,500 miles and must have swept over the entire Oceanus Procellarum. Be this as it may, Wargentin and the neighboring lowland probably have a common flood history.

*Rills and Rill Pits.*—Among the most difficult of the moon's enigmas is the problem of the "rills." Narrow defiles, often tapering at either end, they suggest fissures; but fissures taper downward also, and many of the rills have flat bottoms. Deep canyons, with parallel steep walls, they suggest stream beds; but stream beds have continuous descent in one direction, and the rills run up hill as well as down.

Here again the Imbrian deluge affords a clew. Close by Julius Cæsar, and in the same district of pasty—or, at least, non-liquid—overwash, lie the great rills of Ariadæus and Hyginus. The rounding of their edges marks them as antediluvial features; what was tbeir condition before the flood? Certainly not the same as now, or they would have been filled and obliterated. I imagine them as yawning chasms three-fourths of a mile wide at top and several miles in depth. As the swift tide rushed over them a small portion may have been arrested and engulfed, but the chasms were not filled until the torrent stopped. Then that which spanned them sank down, coming to rest a short distance below the edges, and so forming the visible floors. The pits that interrupt these floors are definitely related to the rills and cannot be classed as impact craters. Possibly here and there an arch of debris that had clogged the crevice gave way, letting wbat lay above it pour into the abyss below. Possibly there was moisture in the crevice, and the inrush brought heat enough to cause explosions of steam. If the floor fell in, the pits should be rimless; if it was blown out, they should be rimmed. I was not able to satisfy myself as to their actual character, and recorded observations are discrepant, but the features are not too minute for accurate determination.

In a part of the rill of Hyginus the pits are set so close tbat their edges adjoin; other rills are composed wholly of pits, and these lead by gradation of characters to rows of separate pits where no rills are visible. Fine illustrations of tbe last may be seen along the western base of Copernicus, almost half way to Eratosthenes. If my conjecture is correct, these mark the line of a fissure tbat was filled by a molten flow connected with the formation of Copernicus.

The rills that have no visible bottoms, but are seen only as black lines, are the unfilled fissures necessary to complete this series of features at the opposite end.

*White Streaks.*—The only remaining great group of features are tbe white streaks. These are bands of color, sometimes faint, sometimes brilliant, but always indefinitely outlined, like the tail of a comet, and some of them stretch for long distances across the moon's surface. Their courses are independent of the configuration. They pass up and down the slopes of craters without either modifying their forms or being interrupted by tbem. The more prominent of them, and probably all, occur in systems, and tbose of each system radiate from some crater. This crater is itself lined with white and is usually more resplendent than the radiating streaks. We need not take time to consider the various conjectures which have been published concerning their origin. It suffices to say that all but the least plausible of these conjectures have been advanced as suggestions merely and have not been fully indorsed by their authors; but there is an unpublished suggestion, made by Mr. William Wurdemann, of Washington, which is at once so apt and so simple that I am comfident it contains the essence of the theory that will finally be adopted. Mr. Wurdemann is one of a number of students who have independently advocated the metoric origin of the lunar craters, but his views have never been published. In a letter on the origin of tbe lunar topography, addressed by him to Dr. B. A. Gould, occurs the following passage: "The most remarkable appearance on the moon, for wbich nothing on earth furnishes an example, is presented by those immense radiations from a few of the larger craters—perfectly straight lines as though marked with chalk along a ruler—starting from the center of the crater and extending to great distances over every obstruction. My explanation is that a meteorite, striking the moon with great force, spattered some whitish matter in various directions. Since gravitation is much feebler on the moon than with us and atmospheric obstruction of consequence does not exist, the great distance to which the matter flew is easily accounted for."

This explanation appeals strongly to the eye. The ray systems resemble splashes so closely that it is difficult to understand why the idea that they really are splashes has not sooner found its way into the moon's literature. It accounts for the straightness of the rays, for their vanishing edges and ends, for their independence of topography, for their relation to craters, for the whiteness of the associated craters, and for the nimbus in wbich the rays sometimes unite close to the crater. It explains the white crests of many gray craters, for peaks would intercept more than their pro rata of the horizontal shower.

It raises also a number of questions, the discussion of which should throw much new light on the moon's bistory. What is the white substance? Why do its traces become faint in passing from the bright uplands to the dark plains? Why do wavy lines replace straight ones in the radiation from Copernicus? Why do certain great rays of Tycbo's system trend toward a point on the rim and not toward the center of the crater? Why are several craters, especially Tycho, surrounded by a relatively dark band inside the bright nimbus?

As no dark rays emanate from the dark craters, it may be inferred that the white substance is peculiar in its tendency to fly about at the instant of collision. It is probably a readily fusible solid. If the ring of moonlets and the earth were once the outer and inner parts of the same whirling mass, tbe moonlets should consist of substances somewhat abundant in the earth's crust. Inquiry may therefore be addressed to familiar fusible substances of pale color. Fusibility in this case is measured by a factor involving the initial temperature, the melting temperature, the specific heat, and the latent heat of fusion; and this must be compared with the amount of energy expended in collision. In the short table I have constructed, the energy necessary to melt a unit mass of a substance is expressed as a fraction of the energy of motion destroyed by the collision of a unit mass. The ratios were computed on the postulates, first, of an initial temperature of —273° C.; second, of an initial temperature of —100° C. Ratios are added for the rock diabase, as a possible representative of the less fusible moonlets.

| Substance. | Relative energy for fusion from —273°. | Relative energy for fusion from —100°. |
|---|---|---|
| Tin | 0·06 | 0·05 |
| Pbosphorus | 0·11 | 0·05 |
| Sulphur | 0·11 | 0·07 |
| Silver | 0·15 | 0·13 |
| Nickel* | 0·30+ | 0·27+ |
| Ice | 0·33 | 0·19 |
| Calcium sulphate* | 0·43+ | 0·38+ |
| Sodium chloride | 0·46 | 0·40 |
| Diabase | 0·69 | 0·61 |

Attention is naturally directed to ice by reason of its abundance on the earth and its whiteness. If it exists on the moon as a solid or liquid, it must also exist as a gas, for it would evaporate until the resulting atmosphere had a certain pressure definitely related to the temperature of the ice. The low temperatures ascribed to the moon by Langley would correspond to an atmosphere of aqueous vapor so tenuous as to be very difficult of recognition; so that the prevalent doubt as to the demonstration of a lunar atmosphere need not bar speculation as to lunar ice. The atmospheric pressure which W. C. Pickering estimates as possible* would indicate a maximum ice temperature of about —40° C. The question whether a moonlet could consist partly or wholly of ice is more vital and more difficult.

Tin, silver, phosphorus, and sulphur are more easily fused than ice and their physical properties are perhaps equally adjusted to the requirements of the problem; but tin and silver are rare substances, while phosphorus, which is less rare, does not occur naturally uncombined, and sulphur, though abundant in combination, is rare in the free state. Perhaps the free iron and nickel of aerolites may stand sponsor for free sulphur or phosphorus in moonlets.

The white bands grouped about Copernicus, though unmistakably derived from that center, do not radiate directly from the crater, are not straight, and are not of even width. They appear also to be diverted by the crater Eratosthenes, passing beyond it on both sides, but leaving a free space in its lee. These characters, and the rill pits previously described, lead me to refer the bands to a swift liquid flow over the surface. The flow probably included two substances, the darker of which, occupying interspaces between the pale bands, is not distinguishable in color from the surrounding maria. The straight featbery rays from other craters are referred, in contradistinction, to jets or sprays projected free from the surface.

*Retrospect.*—In the preparation of this manuscript I have been gradually drawn from the attitude of the judge to the attitude of the advocate. This transformation is bnt an echo of the bistory of the investigation, for starting with two working hypotheses, the impact and the volcanic, I soon found that the details of crater forms accorded so perfectly with my theoretic conception of the results of impact and so imperfectly with the results of volcanic action that further consideration of volcanic possibilities was unprofitable. Brief examination of other theories, as they were discovered one by one in the literature of the subject, satisfied me that they could not compete with the impact theory as interpreters of crater form, and thus I was led to devote myself to the development of the impact theory.

As one after another the obstacles in its path were found to be movable, and as one after another the obscure phenomena of the moon were found to be illuminated by its light, it gradually ceased to be viewed as a tentative explanation and was adopted as the real explanation. The tendency toward advocacy thus sprang from conviction, but it has been furtber promoted by the consciousness that there are many in my audience who do not share with the student of geophysics his conception of the plasticity of rock masses.

Our everyday experience tell us that rock is brittle, and the correlative fact of its viscosity is not practically accepted on the mere dictum of the physicist and the geologist, unless their paths of approach are to some extent retrod. So results of impact which seem to me entirely natural are to some of you extravagant and inconceivable; and if the impact hypothesis is to abide with you, it must ingratiate itself by an attractive array of accomplishments.

The analytic examination of volcanic processes left the possibility that the small craters of the moon are maars, the results of explosion without eruption of lava; the tidal process might perhaps make large craters, but could not make small ones. These are the only suggested reactions originating in the moon itself which appear competent to produce the crater forms actually observed. Taken together, they cover all the craters, but they cannot be applied as a joint theory without arbitrarily dividing a series the gradation of which is complete as to both size and form. The impact theory applies a single process to the entire series (excepting only the rill pits), correlating size variation with form variation in a rational way. Specialized by the assumption of an antecedent ring of moonlets, it accounts also for the great size of many craters. It brings to light the history of a great cataclysm, whose results include the remodeling of vast areas, the flooding of crater cups, the formation of irregular maria, and the conversion of mere cracks to rills with flat bottoms. It explains the straight valleys and the white streaks. In fine, it unites and organizes as a rational and coherent whole the varied strange appearances whose assemblage on our neighbor's face cannot have been fortuitous.

*Growth of the Moon.*—In an incidental way there has sprung from this investigation of the moon's craters a theory as to the building of the moon itself. An attempt to develop that theory would lead far afield, but it is due to the crater discussion that its implications as to the moon's history be brougbt togetber, so that their coberency may be judged.

In the breaking up of the postulated prelunar ring there were at first many centers of aggregation—were the moon the only center, the scars of impact would all be small. So long as the masses were small tbe process of aggregation developed little heat, for the heat of impact depended almost wholly on velocities created by mutual attractions. Tbat particular moonlet which became the nucleus of the moon may therefore be conceived as cold, or at least as sufficiently cool to be solid. As the moon's mass grew the blows it received were progressively harder, and for a time their frequency also increased.

The rate of heating probably reached and passed its maximum while the mass was materially less tban now. During the whole period of growth the surface lost heat by radiation, but the process of growth cannot have been slow enough to permit the concurrent dissipation of all the impact heat. On the one hand there should have been some storage of heat in the interior, and, on the other hand, the stored heat can never have sufficed for the liquefaction of the nucleus. Toward the close of the process, when blows were hard but rare, liquefaction was a local and temporary surface phenomenon, but the general temperature of the surface was low.

Impact heat being evolved simultaneously in the sur-

* Der Mond, page 389.

† Der Mond, page 375.

‡ While engaged in telescopic study I did not realize the importance of close attention to the details of this district, and these pages will go to press before I have opportunity for renewed observation.

* Latent heat of fusion not known, and ratio therefore too small.

* Astronomy and Astro-physics, 1892, p. 778.

face and the subsurface, was dissipated more rapidly from the surface, so that there was a subsurface zone of relatively high temperature. The zone thus inferred deductively is also inferred inductively from the disparity of cavities and rims in the case of large craters; but, on the other hand, there is little evidence of the wrinkling which, theoretically, should result from the adjustment of a cold crust to a cooling nucleus. The parallel topography southeast of Mare Serenitatis is due to sculpture, and not to buckling. The Apennine range, sometimes described as a wrinkle, is part of a crater rim. The great cliff called Altai mountains probably marks a fault, but has not the habit of a range lifted by tangential thrust. The only indubitable flexures that may be ascribed to crustal adjustment traverse the maria, whose smooth floors are admirably adapted to their display. They have anticlinal and monoclinal forms, but are so gentle of slope that they are seen only near the terminator, and can represent but a minute amount of arc shortening. It is therefore probable that the final shrinkage of nucleus was small, and the antecedent storage of heat correspondingly small. During the whole period of growth the body of the moon was cold.

This sketch of the life of our nearest neighbor has but little in common with the accounts of other biographers. To her has been ascribed a fiery youth, after the manner of the sun, a middle life of dissipation, like Jupiter and Saturn, a hardening and wrinkling old age, toward which the earth is tending, and, finally, the end of change, death. If the record of her scarred face has now been read aright, all that remains of the old narrative is its denouement: the moon is dead.

*Age of the Moon.*—Selenographers are not yet satisfied that the condition of the lunar surface is constant, although the history of their search for changes is discouraging. If the moon's face shall prove absolutely incommunicative of modern change, it cannot be expected to reveal the date when its expression last was varied; but, strange as it may seem, the earth can give a partial answer, for the earth was an actor as well as a spectator of the moon's drama, and the record of its participation lies somewhere among the archives of its crust. While the moon was growing the relations of orbits and attractions were such that any moonlet which narrowly escaped collision with the moon was enormously perturbed, acquiring an entirely different orbit about the earth. Many must have been so directed as to collide with the earth, and the traces of their collision, if ever discovered, will tie together at a new point the chronologies of satellite and planet.

The results of collision with the earth may have been very different from the lunar phenomena. The energy of impact determined by the earth's attraction was twenty-two times as great as that determined by the moon's. It would suffice to melt a body of diabase thirty times as large as the moonlet. The shock was somewhat lessened by the atmospheric cushion, but a moonlet of medium size must have developed an immense quantity of heat, and may be imagined to have projected molten rock far and wide, just as the white streaks were projected over the moon.

Does the earth exhibit impact craters? If not, then erosion and sedimentation have destroyed them, and the Cenozoic era did not witness the building of the moon. Is any horizon of stratified rocks generally or widely characterized by molten disjecta? If not, then the moon was already a finished planet in Paleozoic time. Should both questions be answered in the negative, and the lunar event thus relegated to the hazy dawn of the geologic day, is it then possible that the earth, by taking tribute from the moonlet swarm, introduced into its crust an element of heterogeneity, which initiated not only the differentiation of continental and oceanic plateaus, but the series of geographic transformations of which geologic structure is the record?

*Acknowledgments.*—Before my final bow is made it is due that a moment be given to recognition of the facilities and aid I have received in the conduct of the investigation. Through the courtesy of Captain McNair, superintendent of the Naval Observatory, and with the cordial co-operation of the astronomers of his staff, I have been enabled to study the lineaments of the moon's face through the great Washington equatorial. The kindness of Prof. Rood and Prof. Hallock accorded me ample space and facilities for experimentation in the Physical Laboratory of Columbia College. The courtesy of Prof. Langley, Secretary of the Smithsonian Institution, and the generosity of Prof. Hale, of Chicago, secured for my study fine series of lunar negatives and photographs.

The progress of my work has carried me in many directions beyond my proper field of physiography into the fields of physics and celestial mechanics, and in these unfamiliar ways my hesitating feet have been guarded and guided by certain masters in those fields whom I am no less fortunate than proud to number among my friends. I refer to Prof. Newton, of Yale College, and to our fellow members, Dr. Barus, Prof. Abbe, and Prof. Woodward.

## STANHOPEA LOWII.

OUR illustration gives a representation of this beautiful new plant, which first flowered with the importers of the species, Messrs. Hugh Low, of Clapton, in December, 1892. It was shown in flower quite recently at the Royal Horticultural Society's meeting on November 14, 1893, when it received an award of merit. As will be seen in the figure, it differs from the usual forms of Stanhopea as seen in gardens, in being hornless, in that respect somewhat approaching S. ecornuta and S. eburnea, which has inconspicuous horns at the base of the lip, and in being identical in form only with S. amesiana, a species also imported by Messrs. Hugh Low & Co., and which may perhaps be regarded as a white form of the species under notice. The flowers of S. Lowii have sepals and petals of a whitish-buff color; the petals obscurely marked with small, reddish dots. The labellum is of ivory whiteness, with some purple lines or blotches in the interior of the hypochile. Stanhopeas are not in fashion just now, or this would have been an introduction to have caused a great stir among orchid growers. Years ago the fine collections of orchids staged at the famed Chiswick shows of the Royal Horticultural Society did not disdain to include a large specimen of S. tigrina, Devoniensis, or S. oculata, and whenever exhibited, the Stanhopeas came in for a fair share of admiration. Even now, when seen in flower in our orchid houses, a Stanhopea arrests attention more than many costly species which have not so singular a form, consequently they are tolerated in many places, rather than cultivated in the manner which their extraordinary showy and fragrant though rather fugacious flowers would warrant. S. Lowii is a New Granadan species, and, like all the other Stanhopeas, should be grown in a basket, in order that its descending flowers may be protruded without hindrance. It was described by Rolfe in the *Kew Bulletin*, 1893, p. 63, and in the *Orchid Review*, vol. i., p. 177, Fig. 12.—*The Gardeners' Chronicle.*

STANHOPEA LOWII: FLOWERS IVORY WHITE.

## THE CHESTNUT OAK.

QUERCUS PRINUS is by no means a new-comer in our midst, but for all that, it is not nearly so often seen as its merits warrant. A specimen sent to us from the Duke of Northumberland's pleasure grounds at Albury, near Guildford, has induced us to have an illustration made. It is a handsome deciduous or nearly evergreen tree of large size. The general form of the leaf is well shown in the cut; in texture it is firm, rather thick, and of a rich green color. The shortly-stalked acorns are rather large and pointed, of a bright shining brown, set in a tubercled downy cup. The species is very variable, hence many names have been given to it, and much difficulty is experienced in sharply defining the varieties. It is sometimes called Q. Mirbeckii, though we do not find that name in any authentic list at our disposal. Perhaps Q. Michauxii may have been intended, a species sometimes considered as a form only of Prinus. Q. Prinus has a wide distribution in the Atlantic States, extending from Massachusetts to Ontario, and south to Alabama, and west to Kentucky and Tennessee. According to Sargent, the bark of this oak is preferred to that of other white oaks for tanning purposes.

Why the name Prinus came to be attached to an American tree is not obvious. The Greek *prinos* is generally considered to have been the evergreen oak, Quercus Ilex.—*The Gardeners' Chronicle.*

QUERCUS PRINUS—THE CHESTNUT OAK: SUB-EVERGREEN.

## THE DRIED APPLE INDUSTRY IN FRANCE.

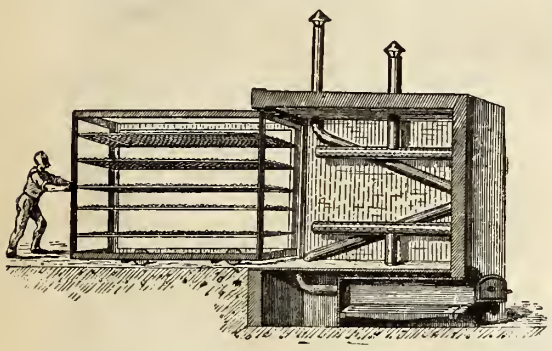
IT is principally in Sarthe, Maine-et-Loire and Indre-et-Loire that the dried apple industry has assumed a relative importance in France. The chief centers of manufacture are Le Mans, La Fleche, Beauge, Saumur, and Chinon. Through the Loire the product reaches Nantes and Saint-Nazaire, whence it is directed toward England. Favored by this exceptional situation, it is now nearly a century since the peasants of this region sought and put into practice a method of preserving

the fruit that they could not sell in years of plenty, while communication with the great centers of consumption was wanting, and navigation was so slow that it was impossible to think of exporting fresh fruit.

For want of special apparatus, some of the cultivators treated their fruit in baker's ovens. The not very inviting aspect of the product greatly injured the sale thereof outside of the country of production.

It was not until about 1830 that the processes of drying having been improved, the trade in dried apples assumed a certain importance. Some merchants of Saumur took the initiative of sending specimens of these fruits to the principal cities of Europe. Well presented in pretty osier baskets, they obtained recognition, and in a few years the transactions acquired a certain importance and the industry became a flourishing one. But toward 1880, despite abundant harvests, the manufacture sensibly abated, and in 1885 it came very near being abandoned. It was the epoch at which American apples began to appear in the markets of Europe. England alone continued to supply herself from Touraine, but the orders became rarer and rarer.

This situation has unfortunately not been modified. Dried apples of American origin are making a daily increasing competition with those of Saumur, and to which is added the German competition, the Germans



RIBES' STOVE FOR DRYING APPLES.

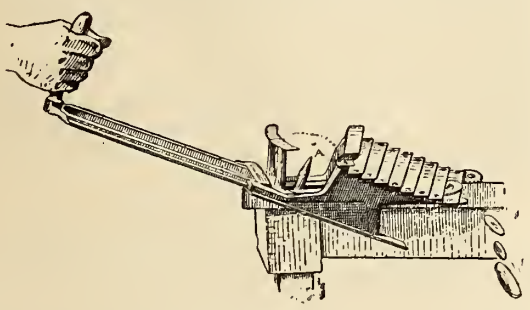
having soon begun to follow the path that the Americans had entered with so much success.

It must be recognized, too, that for forty years, even in the times of the greatest prosperity of their industry, the Saumurians had made no effort to improve their products or to render the preparation of them cheaper. All sorts of fruit were used without selection or discernment—fruit that had fallen prematurely, wormy fruit and fruit gathered too late, and decayed fruit. The peeling and drying were done without much care, and the appearance of the dried fruit left much to be desired.

The Americans, on the contrary, had come to France to make a closer study of the processes of manufacture, and on their return home installed true centers of industry and gave their products an appearance such that those of Saumur could not support a comparison. Then, soon spurning trodden paths and strong in experience, they created entirely new processes of manufacture, and gave especially a new direction to the commercial organization of fruit culture.

In France, for the preparation of dried apples, special fruits are necessary. The two species best adapted to this manufacture are: (1) the golden pippin, often confounded with the Canada pippin, and (2) a local apple proper to Saumur, the farmyard apple. These apples often reach a circumference of 12 inches.

The first, during drying, lose from 75 to 80 per cent. of their weight, and the second less than 80 per cent. All the other species give fruit that is too small or that loses 85 and even 90 per cent. of its weight. This considerably increases the net cost of the dried apples and consequently renders their sale difficult or unprofitable. Such fruit can be utilized only in years of abundance.



For this manufacture, it is customary to gather the apples before complete maturity. In our opinion, this is a bad practice. The picking is done by hand. To this effect ladders are placed against the tree or fruit pickers are employed. The simplest of them is a receptacle composed of small plates in the form of a basket and fixed to the extremity of a pole. The apples are then put into osier baskets and carried to the works, for the industry in improving has been transformed; the desiccation is no longer done on the farm, but by manufacturers, who buy the fresh apples from the peasants. It is necessary that the picking shall have been done with the greatest care, since any blemish will show later on upon the dried fruit. Upon reaching the factory, the apples are peeled with care, the minutest particles of skin being removed with a knife. The bruises produced by birds or the falling of the fruit are also very carefully removed.

Formerly, the core and pips were left in the fruit, but at present it is the general practice to remove them, this rendering the desiccation easier and being easily done with machines.

The apples thus pared are laid side by side upon galvanized iron trays and introduced into a baker's oven heated to 90 or 95 degrees. Therein they are left until, attacked by the heat, the external cells have become hardened and formed a sort of artificial skin. This takes about four hours. The fruit is then taken from the oven and set aside to cool.

Before the cooling is complete, the apples are submitted to a first operation, that of *tapage*. To this effect, they are taken between the thumb and forefinger of each hand, and, on making them revolve, they are slightly compressed with the fingers. Sometimes there is used for this purpose a small tool formed of two boards 4 inches in width and 24 in length, united at one of the ends by a leather hinge.

After undergoing this operation the apples are put back upon the tray, care being taken in depositing them to turn them over, that is to say, to place uppermost the surface that previously touched the tray. The apples are then carried to the oven, which is this time heated to a temperature not exceeding 90 degrees. Herein they remain for five or six hours, and a little longer when the fruit is very large. After being taken from the oven they are pressed a second time, but much more strongly than before, so as to leave in each of them a thickness of but a tenth of an inch at the most. They are afterward put back in the oven for a third time until they are thoroughly dried. Sometimes it is necessary to place them in the oven for a fourth time in order to obtain a complete desiccation.

A few modifications have been recently introduced into the manufacture. There is a tendency to abandon the baker's oven, and many of the manufacturers of Saumur are using stoves or driers. These driers (see figure) resemble the Agen stoves of Marcheron and of Ribes. They have the same system of heating, and we find in them the same shelved car. It is necessary, as in these stoves, to reproduce all the phenomena of oven drying. The trays, placed upon the shelves of the car, are easily introduced into and removed from the drier. The heating is continuous and the fruits remain outside of the drier only for the time necessary to flatten them. The result is a notable saving in time and fuel, but such saving, especially as regards fuel, would be much greater were evaporators employed.

Dried apples fail, in general, with respect to desiccation. The use of the evaporator would permit of obtaining a more perfect and, at the same time, a less expensive desiccation. The drying finished, the fruit is sorted according to size by means of riddles. The large fruit of from 20 to 22 to the pound is put into pretty osier baskets containing from 18 to 35 pounds and shipped to England and Russia. The medium sized fruit of from 25 to 55 to the pound is shipped in similar baskets to England. This fruit of the second category is delivered to the north of Europe in boxes. The small fruit of from 35 to 40 to the pound is put in baskets or boxes and shipped to Belgium and sold in France.

Dried apples are manufactured with and without cores. The preparation is exactly the same in both cases. The coreless fruit is shipped to every point except England, where the whole apples are preferred, the claim being made that it is the pips that give a perfume to marmalades and preserves. For a short time past there have been manufactured at Saumur sliced apples like those of America. They are dried in the same ovens as the compressed apples. They are sold in cases of 550 pounds. The manufacturers of Saumur claim that apples thus dried in thin slices lose their perfume and taste. We believe that this result is greatly due to the method of drying, for no such complaint can be made of the American apples. And even though the latter had less taste and savor than the compressed apples of Anjou, we could not draw the same conclusions as the Saumurians.

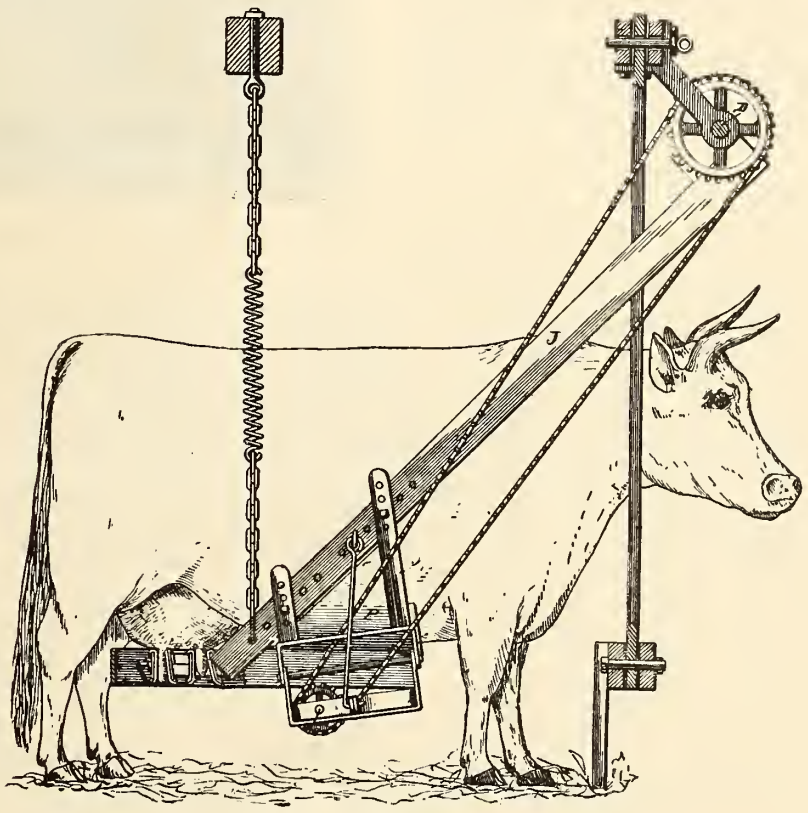
The compressed apples are prepared from selected fruit. The American apples, on the contrary, are prepared from inferior and damaged fruit. This difference of origin would, it seems to us, suffice to explain a difference of quality. In our opinion the compressed apples should be a *produit de luxe*, manufactured with all the special care demanded by a high priced product, while the apples dried in slices or quarters are merely an ordinary product by means of which the producer utilizes fruit that would sell at too low a price in a green state. The compressed apple of Saumur is an industrial product, while the American is an agricultural one.

The waste derived from white fruit amounts to 25 and 30 per cent. The most advantageous manner of utilizing such waste is to convert it into marmalade, pasties and jelly. In order to prepare marmalade, the material is put into a basin with water. As soon as the cooking is finished the contents are passed through a very fine sieve. In order to prepare pasties, less sugar is introduced and the marmalade obtained is spread upon trays and introduced into an evaporator. Finally, to make jelly, the material is cooked in such a way as to obtain a liquid bouillie; which is afterward strained through a piece of linen. —*La Science Moderne.*

## A NEW COW MILKER.

VARIOUS mechanical devices have been invented to milk cows. Among them is the rubber glove plan, which fits upon the teats and is connected with an air pump. Fifty or a hundred cows, it is said, may be thus connected with one air pump, operated by a steam engine, and the milk sucked simultaneously from all the udders, and conducted in pipes to a common receptacle. This plan would be good, only it is found not to operate well. The cows' bags are somehow spoiled by the operation, and the milk refuses to flow. Another method is to insert small tubes into teats, to keep them open and allow the milk to outflow by gravity. This also has proved injurious to the animal.

J. Westgarth, of Lily Lake, Ill., is the latest aspirant for milking cows by machinery. His contrivance we here illustrate. The poor cow is confined in a strong frame, and her teats are put between mechanical squeezers. Cams upon a rotary shaft operate the squeezers something after the manner of hand work. Steam, electricity or water power may be used to work



PATENT MILKING MACHINE.

the cam shaft. The old cow probably says to herself, "What queer fellows these inventors are!"

## THE VILLAGE LEATHER INDUSTRY IN RUSSIA.

THE leather industry is one of the most important in Russia, the production being very large and the trade widely spread among the inhabitants. Statistics show that tanning is carried on as a village industry in 44 governments, occupying about 9,500 households, or about 21,000 men, and that the annual production amounts to 12,000,000 rubles, or about 28 per cent. of that of the factories. The production of wrought leather is spread over forty governments, and occupies 85,000 men, the annual production being about 26,000,000 rubles. The Russian minister of finance has recently issued a report upon Russian industries, in which it is stated that the large manufactories do not compete to any great extent in this branch of trade, consisting principally of boots and shoes, chamois goods, harness and other kinds of wrought leather. A large number of men are also employed in tanning sheepskins used for clothing in the various villages. The value of the annual production of these articles is estimated at 20,000,000 rubles, or about ten times that of the manufactories. It is not known at what precise date the village tanning industry originated; but there is no doubt it existed in this form long before it became a regular manufacturing enterprise. The landowners rendered some assistance toward developing the industry, as it was their custom to apprentice some of their peasants to some form of trade, these young men on their return home practicing their trade on their master's estate. The leather industry is carried on with some difficulty in the various villages, owing to want of capital, insufficient knowledge and difficulties in procuring raw material and in disposing of their goods. The villagers purchase their raw material in the villages and bazars, or from special middlemen. It is also a matter of difficulty for them to acquire the necessary materials for dressing the hides, as they are generally unable to procure bark directly from those who collect it, and are obliged to buy it from the middlemen. The methods practiced by the cottagers are

very simple, even crude and primitive. They have rarely a workshop, but content themselves with the cottage which they occupy with their families. The vat used for steeping and tanning the hides is placed in the street, and the hides are kneaded and greased at home. Their instruments are also very imperfect. The work is generally carried on by the members of the family, and only the more well-to-do peasants hire workmen, and these generally live with the family, receiving wages which vary greatly, according to the locality, from 15 kopecks in the Viatka district to 60 kopecks per day (100 kopecks=3s. 2d.) in the Vasilsk district of the government of Nijni-Novgorod, their food being provided. In some places, as for instance in the Chernigov district, the peasants club together to buy materials, and work in common. The tanning process lasts but three months in the government of Tver, and from six weeks to two months in the district of Chernigov. The principal consumers are the peasants themselves, who are not very exacting in their choice. The profits accruing from this trade cannot be regarded as very large. In the Viatka district they amount to about 5 or 6 per cent. clear profit of their gross receipts. The highest profits are realized by those who do piece work for the large manufactories, hides and materials all being found. In the government of Moscow a cottager assisted by a family of three persons will dress hides to the value of 1,800 rubles a year, and make a profit of about 13 per cent. Tanning is carried on as a village industry in the governments of Saratov, Perm, Kazan, Penza, Tver, Poltava, Chernigov, Viatka, and in the Terskoi and Kuban districts of the Caucasus. The extent of the trade varies greatly in the above mentioned localities; thus, for instance, in the government of Saratov there are 240 tanners; in the colonies of the Kamyshinsk district there are 165, while in the government of Perm there are 500 village tanners, with a yearly production amounting to 200,000 rubles. In the government of Viatka, although the trade has been of late years developing into a manufacturing industry, the village tanners produce leather goods to the value of 4,000,000 rubles a year. The Russian government and private institutions, recognizing the importance of developing, improving, and strengthening the village industries of Russia, have continually studied this question, and have taken steps to encourage and develop the village handicrafts.

## THE EXTRACTION OF KAOLIN.

KAOLIN is a mineral that is now becoming of greater and greater importance, and, far from being limited at present to the manufacture of porcelain, the use of it is extended to a certain number of other industries. Competent authors have often spoken of the use of it in ceramics and of a few other applications, but a description of the exploitation of it as carried on at present is still lacking. It is this want that we desire to supply in these few lines.

Kaolin or porcelain clay consists, from a chemical standpoint, of clay in its greatest state of purity. It is generally white, sometimes colored reddish or yellow by various impurities. Its name is a corruption of the Chinese word *Kauling*—the name of a locality where the substance is exploited.

Kaolin is derived from the decomposition of ancient granitic rocks and principally of feldspar. It is met with especially in company with pegmatites and granites containing white mica. Under the influence of certain neutral agents, these rocks are decomposed at the moment of their formation. Some have given birth to common clay and others to pure clays and to kaolin.

We shall recall the history of the discovery of kaolin in France only as a remembrance, as most of our readers certainly know it. At the beginning of the eighteenth century it was known that the Chinese had for a long time obtained a white and translucent paste for the manufacture of their pottery. In Europe, one was still reduced to the production of faience, when the wife of a pharmacist of Saint-Yrieix discovered by accident a bank of white clay in the environs of that city. Kaolin was found. Since then, the discovery of new deposits in other parts of France has only served to increase the consumption of this valuable product. Thus, at present, kaolin is exploited not only in China and Japan, but also in Saxony, England, Cornwall, Hungary, the Greek Archipelago, and France.

Our country, moreover, is one of the best favored in this respect. We find kaolin of superior quality in Limousin and Dordogne, medium varieties are furnished by Brittany and Allier, and inferior qualities are met with in a large number of localities where the soil is clayey. Fig. 1 represents the great cuttings of the exploitation of Colettes (Allier).

In nature, kaolin is found mixed with the debris of feldspathic rocks, from which it is derived and which are in a more or less advanced state of decomposition.

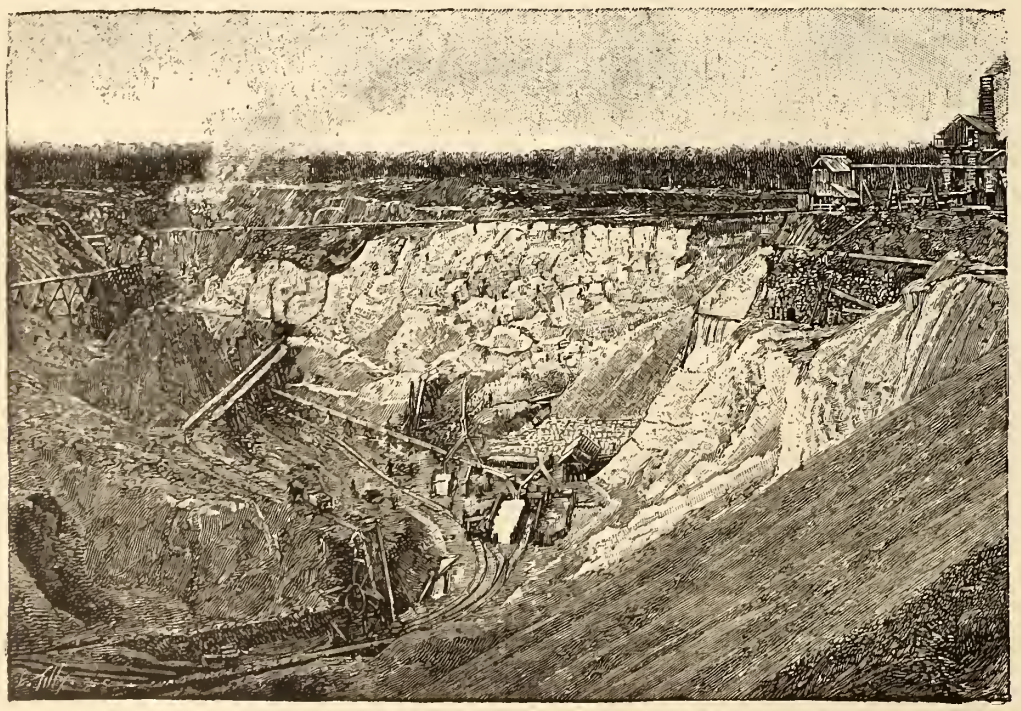


FIG. 1.—THE COLETTES KAOLIN QUARRY.

It is contaminated with granitic residua, sand, mica, etc. In order to free it from these foreign matters, advantage is taken of the difference of density that they present and of the facility that they possess of holding themselves in suspension in water.

The rock is attacked in the quarry itself by a strong current of water furnished by steam pumps. It is gradually disembedded and becomes mixed with the water, which carries it to the bottom of the quarry. Here it follows an inclined conduit which leads it, after a long journey, to a great decanting basin. The debris of rocks and large stones are removed by laborers during its passage through the conduit. The smaller debris are deposited partly in this same conduit and partly in the bottom of the basin. The supernatant milky liquid no longer contains anything but kaolin mixed with fine sand composed especially of very small grains of quartz, feldspar and mica. The muddy substance goes to a draining well, whence it is lifted by pumps to the surface of the earth.

The pumped up water then enters a circular inclosure with a certain velocity, which diminishes therein so that fine sand only is deposited. The water charged with other materials afterward continues its motion in dividing into several courses 12 meters in length, each terminating in small movable gates. Upon properly regulating the velocity of the liquid by a maneuver of these gates, there are obtained deposits composed of smaller and smaller quantities of sand, always finer, mixed with larger and larger proportions of kaolin, until the water is no longer charged with anything but pure kaolin.

This water is received in vast and quite deep basins called "peats," in which the kaolin deposits and assumes a certain consistency (Fig. 2). The water in excess rises to the surface and is drawn off. This water, however, is not lost, for it is taken up by the pumps and serves anew for attacking the rock. Kaolin is introduced into the peats until the reservoirs are nearly full of the settled substance. Then a plug is removed from the bottom and the whole is allowed to flow into desiccating basins. Here it is subjected to a stirring that gives it homogeneousness. When the paste is sufficiently hard it is shoveled up and taken to the driers.

We have seen that the water pumped from the quarry abandons in the first place, along with the sand, quite a large proportion of kaolin. In order to extract the latter from these mixtures, each of the 12 meter courses of which we have spoken is put in communication, through the removal of a plug, with a conduit that carries the deposits to an establishment situated at a lower level. The mixtures of sand and kaolin are then sent from time to time, through a discharge of water, into this establishment below, where the operations that we have just described are renewed.

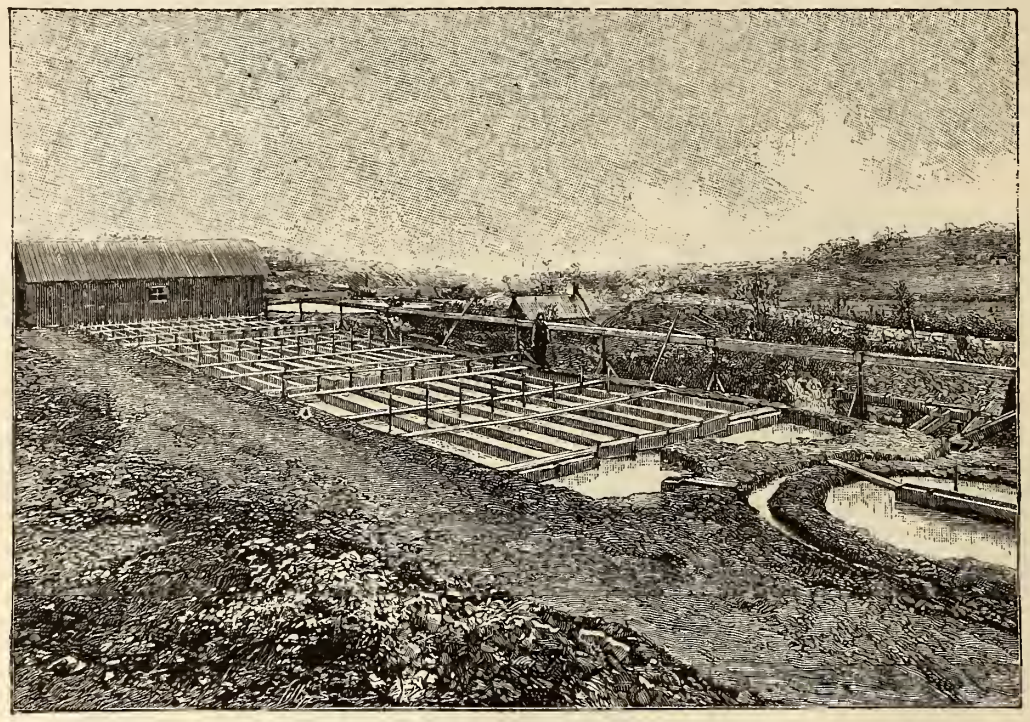


FIG. 2.—DEPOSITING BASINS OF THE COLETTES QUARRY.

The driers are distinguished as air or fire driers. The object of the latter is to assure the continuity of the production, notably in the inclement season, when the air driers are inadequate. The kaolin after desiccation can be delivered to commerce. One of the greatest drawbacks of the kaolin industry consists in the continual modifications of the canalization of the water designed to attack the rock, and which must, in fact, vary according to the direction, thickness, and extent of the banks of kaolin under exploitation.

As for the deposits of foreign substances that are produced in the different decantations, they serve for various purposes. They are formed of variable proportions of kaolin, quartz, mica and feldspar. They enter into the composition of stone ware and artificial pumice stone, and it is also these elements, that, after baking, furnish materials of great strength and hardness.

Alongside of the exploitation of kaolin we always meet with accessory industries that are no less important. Kaolin, derived from the decomposition of feldspars, generally accompanies banks of common clay, use for which is found in the manufacture of bricks.

As for kaolin properly so called, its friability, its softness, its plasticity, its resistance to chemical agents, and, in a word, the various properties that characterize it, render it suitable for a host of applications that we intend calling attention to in another article.—*La Nature.*

## HARDWOOD JOINERY.*

A PAPER on this subject was read recently by Mr. H. W. Barnes, of the firm of Brindley & Farmer, Westminster Bridge Road. It was illustrated by a large number of specimens of varieties of oak, teak, mahogany and walnut, and by examples of old balusters and canopies, by a church screen in Hungarian oak, worked by the lecturer's firm, and by working drawings. Mr. Barnes explained that he intended to restrict himself to modern hardwood joinery, and proceeded: For its production, if the work is to be really good, two things are absolutely essential: good workmen and good, well-seasoned wood, for it is as impossible for a good workman to produce satisfactory work with bad material as it is for an inferior workman to turn out creditable work, however good the material may be.

A short review of some of the hardwoods more generally used may therefore be of interest. Oak naturally takes precedence, and of this there are several varieties—English, Russian, Hungarian and American being the principal. Of these English still stands unrivaled for strength and durability under exposure; but it has been superseded to a very great extent for internal fittings by the others, which are easier to work, and from their milder nature less liable to twist or crack. English oak trees are usually felled early in the year, when the sap has risen, on account of the value of the bark, which is then easily stripped off and used for tanning leather; but oak so felled takes

* Before the Architectural Association, London. From the *Building News.*

about two years longer to season than that felled in the winter. In the latter case, however, the bark cannot be stripped off, and is therefore wasted. English oak trees at times produce planks of great width, one cut down some years ago at the scene of your last summer excursion (Diss) yielding perfect ones 5 ft. wide.

Undoubtedly the finest oak available of late years for interior work has been the variety of Russian, known as Riga wainscot, the grain being very fine, close and regular, the wood a good color and easy to work; but the logs, never very large, are now smaller than ever—in fact, it is very difficult to get them at all, the supply being nearly exhausted. Several other kinds are also shipped from Russian ports; these are principally cut from small trees; the grain is coarse, and, as a rule, they are unsuitable for good work. Hungary produces a very fine variety of oak. The logs are much larger than any formerly shipped from Riga, and at the present time this is certainly the best oak available in any quantity, its great width making it specially valuable for panels. This is shipped at Fiume, in the Adriatic. Hungary, as well as Russia, also produces, however, some very inferior sorts. America sends large quantities of oak to this country; but it is not equal either to Riga or the best Hungarian. The grain is very open, the color poor, usually with a pink tint, and, generally speaking, is unsatisfactory for high-class work. The silver grain is a distinguishing feature of oak and produces the figure. These lines are absent in chestnut, and in many cases form, probably, the only way of distinguishing the two woods. One other point respecting oak is worth referring to—the term "wainscot." This does not distinguish any particular variety or locality, but is applied indiscriminately to all logs cut on the quarter.

Mahogany next claims attention, the different kinds varying considerably, that known as Spanish, coming from San Domingo, being the most valued. In the past this has been extensively used, but is now very scarce, its place being taken by another Spanish variety found at Cuba, which is very close-grained, hard and of good color; but the kinds more generally used at the present time are obtained from Tabasco and British Honduras; Panama and Africa also send mahogany to this country, but the quality of both is very poor.

Of walnut, five descriptions deserve notice, Italian coming first, both for closeness of grain and beauty of markings. This is difficult to obtain at the present time, but a variety much resembling it is now imported from Circassia. English is lighter in color and not so richly marked. A totally different kind, known as black walnut, is shipped at Quebec: it is much softer than the others and almost devoid of markings, but can be obtained in large sizes, and is not likely to crack. A lighter shade of the same wood is shipped at New York and other United States ports. Teak is imported from Burmah, and is especially valuable for work exposed to sea air and salt water; it is also coming into very general use for hospital floors; a variety is found at Bangkok, but the color is not so good. Many devices have been tried for artificially drying hard woods in a short time; but all seem open to objection of some kind or other, and allowing the wood to season by the natural action of the air on the boards and planks is, after all, the most satisfactory, although it is a long process. But it is time to pass from the material to the various methods of working it. Starting at the beginning, the selection of the wood before it is cut to size is more important than appears at first sight, for on this much of the final appearance will depend, and too much care cannot be exercised at this stage, for carelessness in matching will prevent the work ever looking really well, and most likely result in considerable waste. Cutting to length and width is now done entirely by steam saws; afterward the wood is passed through a trying-up machine, which planes it to thickness and width, leaving it quite true and ready for moulding; mortising and tenoning are also done by machinery and absolute truth secured.

So far, machinery is of advantage in every way, and it also relieves the joiner of the very hard labor necessary before its introduction, leaving him free to devote all his energies to the remaining parts of the work, in which a good workman will find plenty of opportunity to display his skill. Up to this point the preparation of all hardwood joinery is practically the same (nor does it differ materially from soft woodwork); but as in its further stages the methods diverge considerably, it will be well to consider these under two broad heads: First, the simpler forms, in which machinery continues to play an important part, and afterward the more elaborate work, which has frequently to be done almost entirely by hand. Formerly mouldings were worked either by planes of various shapes or by routers. The latter were of steel, much the same as modern machine irons, but let into a piece of wood and worked backward and forward by hand—a long and tedious process. The introduction of machinery has, however, done away with both these methods, so far as the ordinary mouldings used for domestic fittings are concerned. In such work the mouldings can and should be turned out in such a manner as not to need touching by hand, and when cost is of great importance, care should be taken that the sections are such as can be worked by passing once only through the machine. Before further considering the question of sections and the important bearing they have, both on the appearance and cost of work, it may be of advantage to call attention to the practice followed of cutting boards and planks to the nominal thicknesses of 1 in., 1¼ in., 1½ in. and so on; but as the saw-cut and planing have to be taken out of this, they never hold the full thickness when worked up, 1 in. finishing ⅞ in., 1¼ in. 1⅛ in., 1½ in. 1⅜ in. Therefore (paradoxical though it may seem), it costs more to produce work 1¼ in. thick than 1⅜ in., for 1½ in. boards must be used in each case, but there will be increased labor in reducing them to 1¼ in. Planks also finish about ¼ in. less, and wide English oak ones sometimes even ½ in. less, as, on account of the greater strength of their grain, the latter are more liable to twist in drying. By keeping this in mind unnecessary waste may frequently be avoided.

Cornices, cappings and similar mouldings will stand infinitely better if built up, and be far less likely either to twist or crack than if made solid, the result being better work at less cost. Care must, however, be taken that each part is properly tongued or cross-tongued. Construction deserves more than a passing notice, for on it very much depends, and every detail should be carefully thought out. It is difficult to lay down any hard-and-fast rule on the subject, as each work should be considered on its merits; but mortises and tenons are always safe and reliable. In the case of very thick doors, however, it is sometimes desirable to put these double rather than single, to avoid any possible warping of the stiles. Where, however, mortises and tenons cannot be employed, handrail screws may frequently be used with advantage. Dovetails are also very good, but apply more especially to sashes and cabinet making. Wall panelings, dados and skirtings should always be tongued together at the angles and into the floor, otherwise dust will find its way between and underneath them, possibly forming a harbor for the germs of infectious disease. Flooring should be laid in narrow widths and tongued at the joints; this gives every opportunity for good secret nailing. Large columns will never stand if made solid, but will crack and twist out of all shape. If, however, they are made in sections, the difficulty is entirely avoided, the result being very much better work at no increase of cost, but rather the reverse. When great strength is required, such as in an open-timber roof, solid wood must, of course, be used.

The various systems of mitering next claim attention. In cheap joinery the work is framed up square and the mouldings mitered in afterward on the top of the panels; but this method is open to serious objection, the stability of the mouldings depending entirely on nails driven in at an awkward angle, and if these chance to go through the panels instead of into the stiles and rails, and the panels shrink, the result will be an unsightly crack. Except in the case of bolection mouldings, which can be rabbeted onto the stiles, etc., and properly fastened, this treatment should never be adopted for good work. An infinitely better system, and the one usually employed in high class joinery, is to work the mouldings on the solid of the stiles, rails, etc., cutting out the stiles to receive the rails, and so forming a miter. A third method is applied more especially to ecclesiastical joinery. When the work is ready for framing up, it is most desirable to put it together and let it stand as long as possible before actually gluing and wedging, as, no matter how dry the wood may be, it is sure to shrink when first worked; in fact, there are well-authenticated instances of this occurring when reworking old beams which have been in position for 200 or 300 years. Framing up and cleaning off afterward are two very important matters. Shoulders, which in soft woods need hardly be touched after leaving the machine, must, in hard woods, be gone over carefully by hand; otherwise good results cannot be obtained. Miters, too, demand very special attention. For all such work the tools differ very materially from those used for soft woods, the most effective having either metal faces or being entirely of metal. In finishing off, these tools are also of the greatest assistance, as glasspaper should on no account be used. But it is when the more elaborate and intricate forms of ecclesiastical joinery are entered upon that the greatest demands are made on the skill of the workman.

Ancient work was, of course, all done by hand, and still fills us with admiration for its beauty, variety and general excellence. Evidently in those days time was only a secondary consideration, and nothing was spared to make the work worthy of the high purpose for which it was intended. Unfortunately, at the present day, time is of so much importance that it is very difficult to devote the same amount of it to any particular work as the old men did; but there is ample proof, even now, that when cost is not the first consideration, work of high quality can still be produced. Vaulted canopies require much care. These, if of any size, should be built up; if worked in the solid they will crack and twist, utterly spoiling the effect, and will, in addition, be much more expensive; but if the ribs are worked singly, to the required sweep and section, rabbeted for the spandrels, then mitered together, the spandrels filled in afterward and the whole covered at the back with strong canvas well glued, they will stand. Very small and specially elaborate canopies must, of course, be cut out of the solid to a great extent. The third system of mitering, already referred to (known as masons' miters), now claims attention. It consists in working the returns of the mouldings in the solid of the stiles, to stop those on the rails, and on the rails and sills to stop the mullions. The actual working of these returns is done after the work is glued up. It is of necessity a more costly method than the others, but there can be no doubt that in certain work it is the only proper way and far stronger than any other. Much old paneling was filled with linen fold panels, which always look well. These, however, seem to have fallen into disuse, which is to be regretted, more especially as they are really inexpensive, considering the good effect produced, the play of light and shade being very pleasing.

In tracery great opportunities occur, but it is only when cut by hand that all its beauty is brought out and endless variety can then be obtained. When, however, cost is of supreme importance, the aid of machinery can be called in, and by its use the mouldings worked, leaving only the angles and pockets to be done by hand, and if the cusp points are simply turned out, the cost will be still further reduced; in sunk tracery the various sinkings can also be done by machinery; the least expensive section consists of a hollow, a second member, more especially if it is a bead, considerably increasing the labor. How to treat the face of hardwood joinery frequently requires much consideration. In the case of oak, the action of the atmosphere would tone it down admirably; but this takes time, and the first appearance of newness is often removed by the fumes of ammonia, which can be regulated to produce any desired shade, and the treatment is a good one when the work is not subject to much handling; where it is, however, beeswax and turpentine are generally applied afterward, as otherwise the damp heat of the hands will leave dark marks; care must, however, be taken that as much of the wax is rubbed off as possible, or the work will very probably turn yellow in time.

After this application the oak will cease to darken, as the wax fills up the pores and prevents any further action of the air. Beeswax and turpentine alone also produce good results on most hardwoods when well rubbed in, and a very pleasant surface is the result, much the same as the slight polish seen on an eggshell. This treatment is also particularly useful for floors; these, however, require periodical attention. Simple oiling is never satisfactory. French polishing is a very general treatment, but is too well known to need any description. It is of vital consequence to remember that damp plays havoc with seasoned woodwork, causing it to swell and warp; it is therefore fatal to put it against damp walls; when it is impossible for these to have time to dry, the wood should be well coated at the back with a damp-resisting preparation, and not be fixed close against the wall. Hardwood joinery is a dry subject—in fact, so essentially a dry one, and affording so little opportunity for making a paper on it attractive, that it is much to be feared the present one has caught the infection and become in its turn thoroughly dry; still hardwood joinery is a matter which deserves some attention, and possibly the facts placed before you may induce a further study of the methods of working, which will certainly prove useful. The introduction of machinery, although materially reducing the cost of production, has not by any means done away with the necessity for skilled workmen; skill, however, can only come by practice following long and careful training, and in some respects the two essentials requisite for thorough work—good workmen and good materials—bear a strong analogy in the careful preparation both require; the forest may contain the finest trees, but unless these are properly converted and allowed to season, much of their value is lost, and a youth may have all the natural qualifications necessary to make a good workman, but without proper training is never likely to reach a high standard of excellence; both the seasoning of the wood and the training of the youth require time.

It must be a matter of regret to all who have the true interest of the British workingman at heart that the system of apprenticeship has almost died out. No doubt it entailed much drudgery, but it gave a man a better insight into his trade and a more thorough mastery of all its details than can possibly be obtained by any other means. Really good men are as much in demand as ever they were, and the more care and attention a man bestows on his work and the greater the skill he brings to bear upon it, the more likely will he be to insure what every good workman desires—constant employment; and beyond this he will have the satisfaction of knowing that he is doing good work—a satisfaction dear to every earnest and honest worker, be he artist or artisan.

## THE COLUMBIAN EXPOSITION.

### IV. LIBERAL ARTS—ENGLAND.

By L. P. GRATACAP.

AMONG the ceramics of England considerable attention has been drawn to the Elton ware, a rather bizarre group of forms in dark and mingled colors, imitating in design the Inca work of Peru. Lord Elton is favorably situated for carrying on his original experiments, as his domains inclose a valuable clay bed, and their distinguished owner has been led by this accident and natural taste combined to establish the potteries from which these novelties emanated. They have proved very popular and their sales surprised the agent who accompanied them to the Exhibition. They suggest the American Rookwood in a way, but are less delicate and dainty, and are semi-barbaric in form and accessories. Still they possess intrinsic interest and much of their coloring is rich and artistic. The exhibit of Staffordshire ware by the Moore Brothers was one of much beauty. The white ware with garlands of flowers and raised ornamentation, the orchid designs also, were very beautiful and natural, and much of it original. Amori were, perhaps, for a chaste taste, somewhat too abundantly used. A. B. Daniell & Sons, of Wigmore Street, London, exhibited the superb *pate sur pate* vases of Mr. Solon.

Here was the famous Jubilee vase prepared for the semi-centennial of the Queen's reign over England, a *tour de force* of the most splendid and supreme vigor. Here is shown the happy and captivating design of the Cupids liberating the enchanted nymphs, whom the severe Minerva had confined. The execution and drawing are very expressive and pleasing, the detail painstaking and the whole from every point of view a miracle of technical power and skill. On the other hand all of the work of this firm is not confirmatory of the highest praise. Perhaps it is pedantic and unreasonable to encourage too persistently a demand for constant freshness, and yet only by such means are new efforts made to realize new ideas, and the panorama of the arts more effectively unfolded and extended. In much of the Daniell ware there was a conventional splendor of color and ornamentation which did not seem distinctively artistic.

The Ault faience of Swadlincote was a rather commonplace and coarse pottery in yellow, blue, green, red, and darker tones. Much of it was in the design of flower pots. The Swadlincote potteries were established in the beginning of the century by Mr. Thomas Sharpe, and are still carried on, we believe, by the Sharpe Brothers. Here were made the "Derbyshire ironstone" ware, embracing "plain and pressed jugs and mugs; bowls of various kinds, ewers and basins, teapots, cups, and jars of various kinds; beef, bread, jelly, stew, and other pans, and every description of household vessels." The "Toby Fill-pot" jugs were made here, and a general assortment of rustic and half humorous articles, while sanitary pottery has occupied the attention of these potters for years and has been extensively used.

Doulton ware, which made such an impression at the Centennial Fair in Philadelphia, was no less conspicuous nor less admired in Chicago. It perhaps became the center of the ceramic exhibit in the English section. Here were glorious examples of ware both in the natural and academic styles, with strength in each. The wonderful Lambeth vases, the plaques, the orchid decoration, the *motifs* from classic fable and the profusion of forms and types made this exhibit a difficult study. Yet amid the variety the eye turned with extreme satisfaction to the blue and brown tankards with romantic decoration. They seem more characteristic

and more interesting. Jewett's remarks (Ceramic Art in Great Britain) are appropriate; he says: "Many of the productions in this stoneware are of extremely artistic character, and evince a purity of taste which is highly meritorious. Some of the jugs and tankards, from antique examples, and which are produced both in brown, blue, claret, and fine white stoneware, are remarkably chaste and elegant, and remind one of the best periods of German and Flemish art. The forms are admirable, and the decorations, whether foliage or animal, incised or in relief, are always thoroughly well considered, and especially adapted to the material, the mode of production, and the use of the object. 'There are no affected imitations of antique types. The spirit of true design is caught with admirable perception and insight, and when color is introduced, it is done sparingly, and with a view to enhance the form of the object and the natural beauty of the material, rather than to conceal either the one or the other.'"

The Coalport china which attracted so much attention was exquisite. It marked the refinement of appreciative decoration, though not very strong or distinguished in design. The Royal Worcester ware was sumptuous. The profuse use of gold in its decoration somewhat vulgarized it. Among the pieces the banquet set, in coral, gold and ivory, with satyr *motif*, was the most striking. The foreign exhibits in the Liberal Arts building were of great importance. Their effect upon all classes of visitors was marked. Great in all respects as the Columbian Exposition has been, perhaps the more marvelous effect of its educational power, in the improvement of the great masses who were introduced by it to a world of beauty and achievement undreamed of by them, will prove to be the greatest.

## PORTABLE OIL ENGINE.

AT the ninety-sixth annual show of the Smithfield Club, recently opened in London, Messrs. Weyman & Hitchcock exhibited their Trusty oil engines of new form with a single cylinder. The engine now exhibited and illustrated below is of 3½ brake horse power, runs at 240 revolutions per minute, and has a fly-wheel of 4 ft. in diameter. It is arranged on a bed plate and frame, with water tank beneath and oil tank between the frames. As will be seen from the engraving, it makes an exceedingly handy little portable engine, and makes a very useful addition to the various forms of the Trusty engine made and originated by this firm. —*The Engineer.*

## BURNED CLAY BALLAST.

By S. E. COOMBS, Assistant Engineer Hannibal and St. Joseph Railroad.

IN localities where gravel beds cannot be found, and broken stone is considered too expensive or is of too poor a quality, the so-called burned clay ballast has come into extensive use, and some of the large railway systems in the Missouri Valley are using it in preference to any other ballast. In locating a pit or kiln, a good clay is sought, and almost any clay can be used if free enough from sand. A light clay is preferred on account of ease of handling. The so-called gumbo is used throughout the West and in Texas it is proposed to turn "black wax" to some account by making ballast of it. As the available clay is always on bottom lands, it is often difficult to obtain good drainage, but the importance of this must not be underrated, as on this very factor will often depend the economical working of the kiln. Consideration must also be taken of the prevailing winds, so that they will help both to dry out the clay and fan the fires. The kiln and tracks are arranged, as shown in Fig. 1, varying with the ground.

The working track is simply laid on the surface, so that it can readily be thrown. No very heavy work comes on it till ballast is loaded out. The kiln is started on a triangular core of old ties and kindlings (Fig. 2) piled about 3 ft. high, and the entire length of the kiln, which varies from 2,000 to 4,000 ft. The kiln is often started for a short length, say 2,400 ft., and lengthened as economical working permits. This core is filled with coal and covered about a foot deep with clay, and the fires are lighted. After this has burned down somewhat, the work is begun on the side toward the working track. The laborers simply cover the side of the kiln with the layer of coal and this coal with a layer of clay 6 in. to 9 in. deep. The work is carried on by hand until a sufficient height is reached to use the machines. When the clay is, in the opinion of the operator, sufficiently burned, the kiln is drawn; that is to say, part of the unburned clay is drawn off the fire and a layer of coal scattered over the surface sufficient for burning the next layer

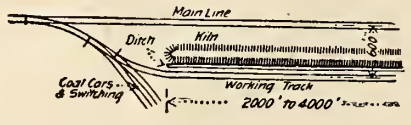


Fig. 1. Arrangement of Tracks.

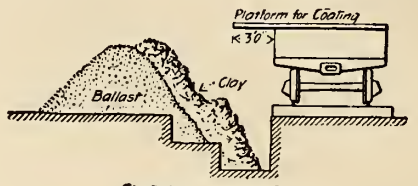


Fig. 3. Cross Section of Kiln at Beginning of Machine Work

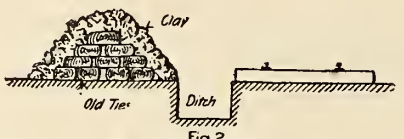


Fig 2 Section of Kiln at Starting. Main Line on Left.

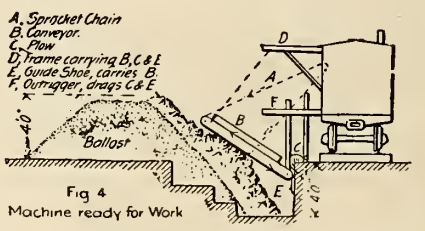


Fig 4 Machine ready for Work

of clay, which is from 6 in. to 9 in. thick. This is shown by Fig. 3.

The spreading of coal is done entirely by hand from a platform about 10×3 ft., rigged over the side of the gondola car which carries the coal, and which can be transferred to each car. Scoop shovels are used, and with very little skill the operators can distribute the coal thoroughly over the surface of the kiln. Coal is also distributed over the surface of the ground, before plowing, so that it gets mixed in the clay and helps to start the new fires after drawing. The plowing, both from the sides and the bottom of the ditch, is done by the machine.

The plant is simple, consisting of two double engines, one set of 10 H. P. and one of 5 H. P., mounted on a flat car. The 10 H. P. engine is geared to trucks for locomotion and also does the plowing; the other runs the conveyor, which distributes the clay over the kiln, both operated by one man. Alongside the car on the rigid frame (but itself movable) is the plow. The conveyor is independent of this, and has one end just below it, so as to catch the dirt which is plowed from the sides of the pit. These conveyors are rubber belts, four feet wide, and are run by sprocket wheels or by friction, and are adjustable. The cost of one machine complete is about $3,500.

The method of operating machines is as follows, and is easily understood by reference to Fig. 4. Clay plowed from the bottom of the ditch is piled up by hand to a height of about four feet to make a sort of shoulder. The plant is then put in motion at a speed of about 200 ft. per minute, plowing from the side and distributing at the same time. When the height of the kiln gets beyond reach of this machine another is put into service with it, having a longer conveyor to reach the top of the kiln. The operation is kept up, requiring no skilled labor except in the superintendence and running of the machines. The principal object is to keep the fires always well covered with clay and burning. The fuel used is ordinary slack coal, and almost any variety of soft coal will do the work. About 560 lb. of coal will burn about a cubic yard of ballast.

Along the Missouri and Mississippi valleys the best season for burning is from just after the so-called June rise to the spring rains. The work is usually done by contract, the railway company furnishing the land, tracks and coal. This method gives the best satisfaction, as the contractor does not feel bound to save coal, which would result in underburned ballast. Partial estimates are given on kiln measurements and the final estimate is made from car measurements when loaded out, so that worthless material is not paid for.

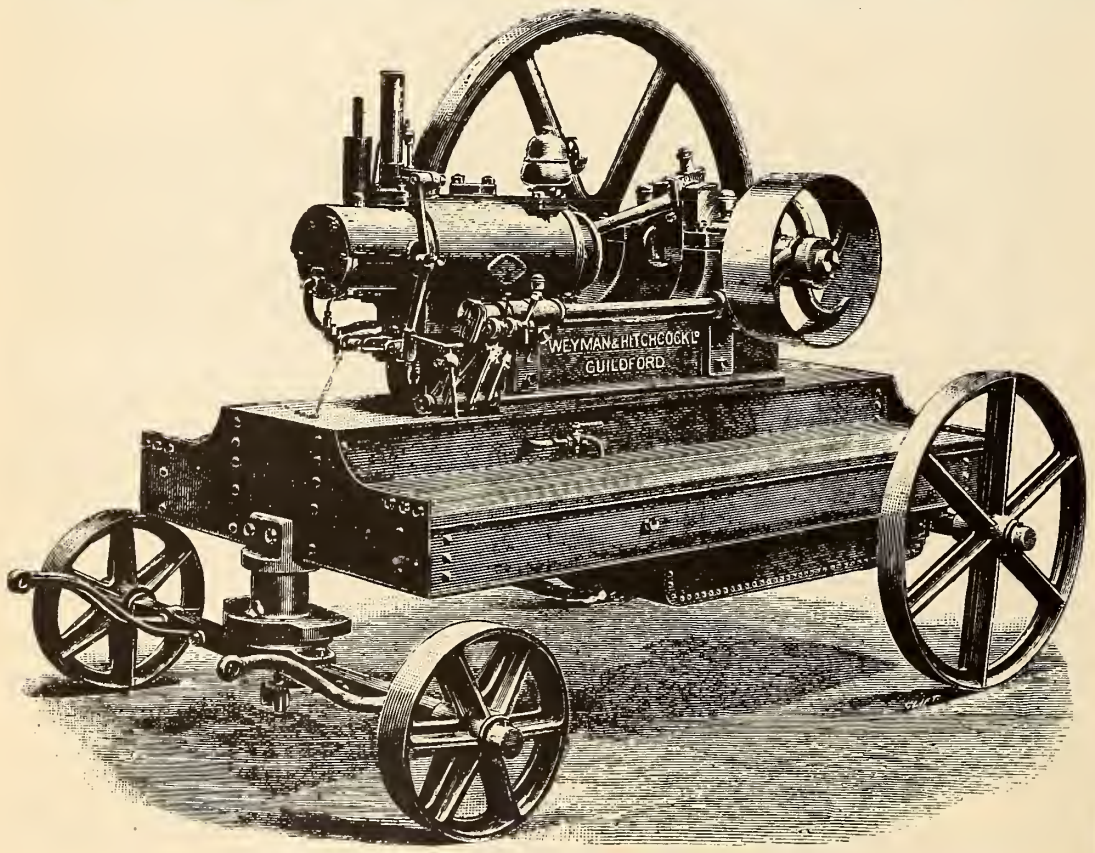
About 1,000 cubic yards per day can be burned in a kiln 4,000 ft. long, and about fifty men are required to operate such a kiln. The cost of ballast thus made is about $1.05 per cubic yard, distributed as follows:

| | Cents. |
|---|---|
| Contract price for burning | *38 |
| Average cost of coal per yard | 21 |
| Loading on cars | 8 |
| Distributing | 9 |
| Putting under track | 22 |
| Interest and depreciation on track | 4 |
| Land | 1 |
| Miscellaneous expense | 2 |
| | $1.05 |

The ballast makes very handsome and easy riding track and has been found satisfactory on most roads where rock is too expensive as compared with it. It is very light, weighing only 40 to 50 lb. per cubic ft., and is thus liable to wash away. Its lightness, however, enables it to be handled cheaply. The principal objection to it is its low crushing strength, making it liable to powder up under the ties and compelling shovel tamping, which is of itself often considered a great objection. It requires renewal in from six to eight years; is quite free from weeds, which are readily cut out; and is said by one superintendent to be easier on rolling stock than any other ballast on account of its elasticity. Figures for this are, however, practically unobtainable.

Track keeps in surface about one-half as well as with broken stone and about the same as with gravel. The same cross section is used as with stone. It cannot be used sparingly, as less than twelve inches under the ties will not give good results. Whether its use is economical is a question of management and locality. Side by side with good stone, however, the latter has the advantage in its superior permanency and stability. The process and machines are patented to some extent and the work is generally done by the patentees.

The cost given above, from five pits, is an actual average, and is high rather than low, as a contract for 50,000 cu. yds. was let this year for burning at 25 cents per cu. yd., an extremely low price. The Wabash Railroad is paying 38 cents, I believe, near St. Louis. I have watched its behavior in the track very closely, and do not think it compares favorably with stone, especially in cost, though of course this is somewhat a matter of opinion. Section men like it because it is so easy to work. The general manager and the general superintendent of the Hannibal & St. Joseph Railroad and allied roads, the general superintendent of the Burlington & Missouri River Railroad, and the division superintendent of the Wabash Railroad are very much in its favor. The chief engineer and two roadmasters of the Hannibal & St. Joseph and Michigan lines and the resident engineer of the St. Louis extension are opposed to it. It may be in the future that the process will be improved so as to make a really first class ballast. The "black wax" experiment is very recent, but bids fair to be successful. The patentees are the Stubbs Ballast Co., Weston, Mo.; the Western Burnt Clay Ballast Co., Cameron, Mo.; and the Davy Clay Ballast Co., address unknown. All three have furnished ballast to the Hannibal & St. Joseph Railroad. —*Engineering News.*



THE "TRUSTY" PORTABLE OIL ENGINE, 3½ BRAKE HORSE POWER.

## THE ANTOFAGASTA AND BOLIVIA RAILROAD.

IT is a singular fact that, while the attention of the world has been drawn to the efforts at building the Trans-Andine Railroad between Argentine and Chile, which still remains unfinished, and the Central (Oroya) Railroad in Peru, which was only opened to Trans-Andine traffic within the current year, the Antofagasta and Bolivia Railroad was quietly pushed across the Andes and has for several years been serving an extensive commerce between the lofty Bolivian plateau and the Pacific Ocean. Its present length of line is 574 miles, terminating at the Bolivian city of Oruro, which point was reached by the extension from Uyuni less than a year ago. A location has been made for a continuation of the line to La Paz, the capital of the republic, a distance of 139 miles, and surveys are in progress for a branch from Uyuni to Potosi, about 60 miles in length.

This road was built chiefly to serve the needs of

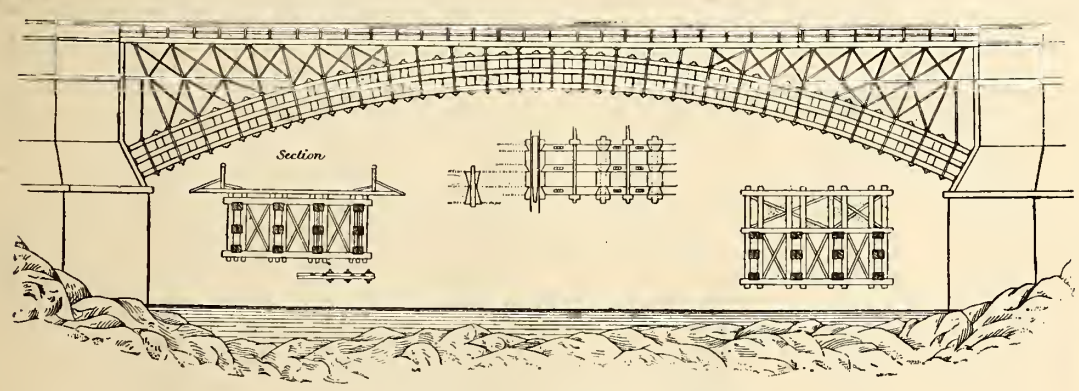
* Variable; this was the price in 1892.

mining interests along the route, those of the Huanchaca of Bolivia silver mining and reduction company being the most extensive. The works of this company are, in fact, the largest of the kind in the world owned and operated by a single corporation, and the capital for building the Antofagasta and Bolivia Railroad was derived almost entirely from the Huanchaca of Bolivia company.

Although not the first railroad in South America to cross the Andes, being preceded by the Southern Railroad of Peru, it is at present altogether the most important of the three existing trans-Andine roads, and would seem destined soon to constitute a link in a trans-continental connection through Argentine upon the building of the proposed extension of the National Central Northern Railroad northward from Jujuy. It is cheaply constructed, as befits a pioneer enterprise in a country where railroad building is difficult and expensive, and in this respect should stand as a model of wise practice for the promoters of other pioneer lines in the Andean regions of South America; except in the matter of gauge, which is 30 in. The track is laid with 36 lb. steel rails, and the traffic carried on this line in 1892 amounted to 416,166 tons of freight and 21,741 passengers. Its gross income for the year was $1,235,316, or $2.152 per mile. The operating expenses amounted to $804.847, thus leaving a net income of $430,469. Of the operating expenses, $33,590 went for costs of administration, $210,724 for movement of locomotives, and $222,832 for maintenance of way and structures, the remainder being distributed among repairs to rolling stock, telegraph, employes on trains and at stations, and police. The above figures are only approximate, being reduced from pesos at 30 cents. The locomotives in actual service number 46, which ran a total of 1,543,570 miles in 1892, being an average of 3,360 miles each.—*Railroad Gazette.*

## THE PERADENIA BRIDGE, CEYLON.

ONE of the noticeable things to be seen on the line of the Ceylon Railway between Colombo and Kandy is the "satinwood" bridge located about four miles from Kandy, the ancient capital of Ceylon, on the high road to Colombo, crossing the Mahavilla Ganga. A good view of the structure can be obtained from the railroad. The original intention was to construct the bridge of satinwood, but the plan was not wholly carried out, as the supply could not keep pace with the demand, and millewood was used to some extent. The general appearance of the bridge is shown in the accompanying engraving, reproduced from *Indian Engineering.* The span of the arch is 205 ft. and consists of four sets of treble ribs, connected by dovetailed keys. The dimensions of these ribs or arches are 18×24 in., 16×24 in. and 16×24 in., respectively, formed of beams 12 in. thick, and 18 in., 16 and 14 in. deep, secured to each other by large dovetailed keys fitted into mortises cut transversely through the beams. The arches or treble ribs were tenoned into wooden sleepers placed against the abutments. The

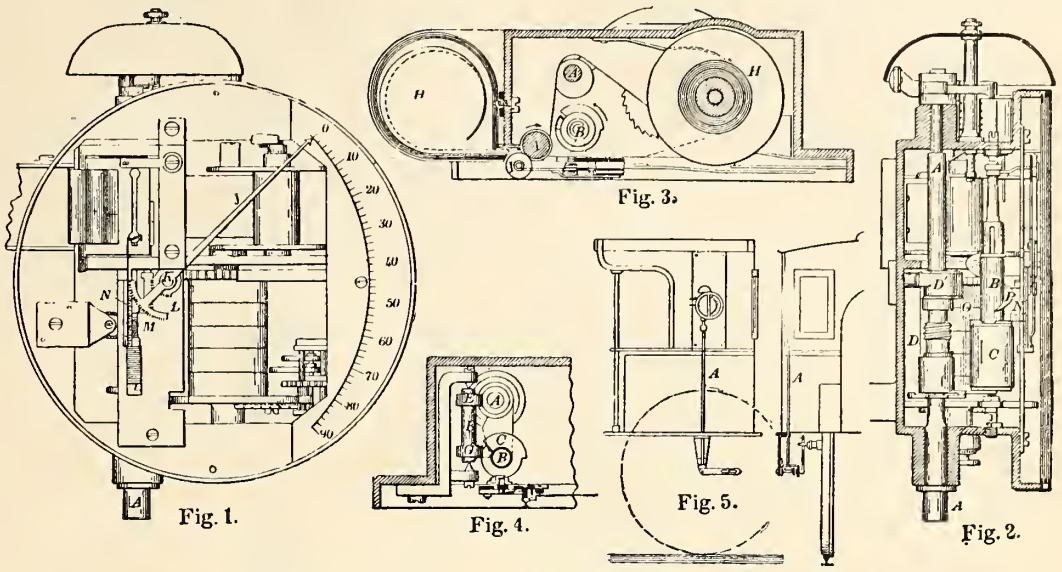



THE PERADENIA BRIDGE, CEYLON.

bridge as thus constructed was completed and thrown open for traffic in 1833. From causes, however, to be expected in the climate of Ceylon and in work of this kind, the entire arch had to be renewed with teak timber in 1855, and that was very ingeniously done without any cessation of traffic. Viewed in any way, the bridge cannot fail to be regarded as a most interesting object; for not only is it a most pleasing picture, but a remarkably novel structure.—*The Railway Review.*

## THE HAUSSHALTER SPEED RECORDER.

IT is a well recognized and undisputed fact that the presence of a speed recorder on locomotives and cars would be of great value to railways, and while many devices have been made for this purpose, few of them have been used to any great extent. One of the difficulties in the way has been to get an instrument which was at once reliable and reasonably cheap. In this country one company has succeeded in bringing a machine to a high degree of perfection and at the same time keeping the price down, which has resulted in its being quite largely used. In Europe several devices have been introduced, and one of them, known as the Hausshalter speed recorder, with such success that there are now nearly 1,700 of them in use. This instrument is contained in a circular iron casing about 12 inches in diameter, having a glass front. The details




MECHANISM OF THE HAUSSHALTER RECORDER.

of the construction of its important parts may be seen in the accompanying illustrations. In these illustrations Fig. 1 is a front view of the instrument, Fig. 2 a perpendicular section, Fig. 3 a horizontal section, Fig. 4 a detail of the principal parts, while Fig. 5 shows the manner in which the instrument is attached to a locomotive. By referring to the latter illustration it will be seen that the recorder is secured to the side of the locomotive cab by small bolts or screws. A shaft, A, extends from the instrument to a bracket beneath the running board. This bracket carries three bevel gears, the largest of which is mounted on the shaft, A, and the two smaller on a short shaft running at right angles thereto and carrying on its inner end a crank which is attached to the crank pin of one of the drivers so that as the driver revolves, the shaft, A, also revolves. The gear wheels are so connected that the shaft always revolves in one and the same direction regardless of that of the driver.

The shaft, A, is shown in each of the illustrations. A second shaft, B, shown in Figs. 2, 3 and 4, is revolved through an escapement by clockwork and makes a complete revolution every twelve seconds. The clockwork is actuated by a spring which is wound from the eccentric, D (Fig. 2), mounted on the shaft, A. As long as the shaft, A, is revolving, the spring is kept wound automatically, but a thumb nut is provided beneath the instrument by which it may be wound by hand when the engine is at rest. The instrument will run without winding for 50 minutes after the engine stops. The shaft, A, also carries a worm, D (Fig. 2), which meshes with a worm wheel, E (Fig. 4), on the shaft, F. On the opposite end of the shaft, F, there is a small gear wheel, G, the teeth of which engage with threads on a weight, C (Figs. 2 and 4). This weight is carried upon the shaft, B, and, although free to move up and down independently, must revolve with it. The threads on the weight do not extend throughout its entire circumference, but are cut out on one side, the cut being beneath the bottom of the threads and of sufficient width to allow the weight to pass freely by the small gear, G.

The operation of the machine is as follows: As the engine to which it is attached begins to move, the shaft, A, revolves, and in so doing winds the clock work, which sets in motion the shaft, B. Through the worm, D, worm wheel, E, and small gear, G, the latter acting on the threads thereon as on a rack, the weight, C, is gradually elevated during a period of twelve seconds. At the end of this period the weight, C, has reached a point where the space having no threads is opposite the gear, G, when the weight falls to its normal position. The height from which it falls depends entirely upon the speed at which the shaft, A, has been revolving, and as the speed of the shaft increases it follows that the height increases correspondingly. The recording mechanism of the instrument is arranged to puncture a strip of paper just before the weight drops, and the height of each puncture above the base line indicates the speed at which the engine was moving at the time the puncture was made.

The paper on which the record is made is carried on two rollers, HH (Fig. 3), and passes between two rollers, II. One of the rollers, I, is geared with the shaft, B, and the other roller is pressed against it by a spring. This gives the paper a motion constant with the shaft, B. A full size sample of the record produced is shown in Fig. 6. In this record the speed is shown by the irregular line of dots, and the space between the dots represents a period of twelve seconds. The lower of the solid horizontal lines represents the base line, and each line above represents 10 kilometers per hour, as marked. Each space between the dots in the first row beneath the base line represents one-half a kilometer; that in the second row beneath represents one and one-half minutes, and in each tenth space there is an additional dot representing 15 minutes. The space between the dots above the record represents one and one-half minutes.

The mechanism which makes these records, although simple, is very ingenious, but an explanation would involve additional engravings and a lengthy description not essential to an understanding of the main principles governing the action of the machine.

The speed, in addition to being recorded on the paper, is indicated by the pointer, J, shown in Fig. 1. This pointer is pivoted at K and carries a rack segment, L. The segment meshes with a rack, M, attached to the peg, N. The peg, N, is free to move up and down in a slot and is pushed up by the shoulder, O, on the weight, C, and down by the spiral, P (Fig. 2), which is a part of the weight, C. As the speed increases and the weight, C, rises, the hand is carried around with a gradual movement, being held when the weight drops by a spring, while the weight again rises. If the weight rises higher, as it revolves, the spiral, P, is carried above the pin, N, and the latter is pushed up by the shoulder, O, the hand moved around and a higher speed recorded. If the height attained by the weight, C, is not so great as formerly, the lower side of the spiral comes in contact with the upper side of the pin, pushes it down, turns the hand back and records a slower speed. It will thus be seen that the hand is adjusted every 12 seconds, but when wished a second pin is provided, by which adjustments are made every six seconds.

The manufacturers of this instrument make several very strong claims for it, one of the most important being that all movements are positive, affording no possibility of slip which shall give an erroneous record. All the main parts are operated by gears which must be broken before any slip can occur, and therefore as long as a record is made, it is correct. The connections are always made to a driver in order to check up the engineer if he slips his wheels, the amount of slip being determined by the dots showing each one-half kilometer run. This is deemed very important, as many reckless engineers shamefully abuse their engines in this respect. Another advantage in this instrument over others is the fact that time, as well as distance, is recorded. This gives exact information concerning the time consumed at stations, sidings, etc.

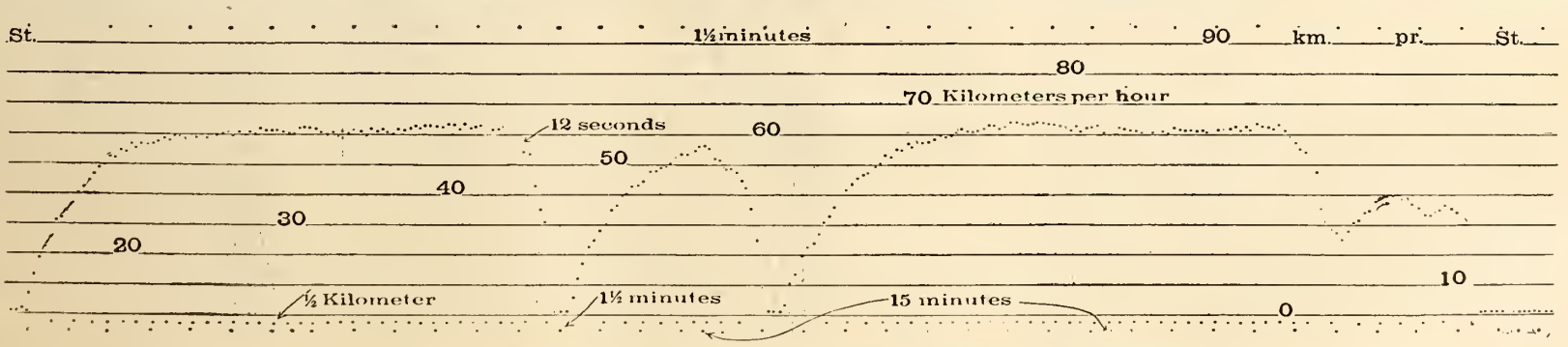



FIG. 6.—HAUSSHALTER SPEED RECORDER—FACSIMILE OF DIAGRAM.

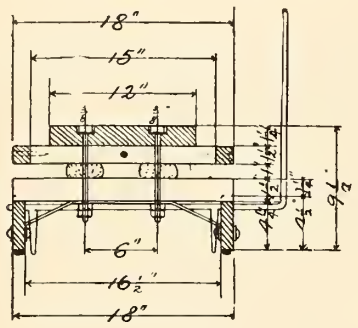
This is necessary to a complete record. Each instrument requires to be graduated for a given diameter of driver, but after it has been correctly fitted to an engine, the wear of the drivers is the only wear which affects the record. The movements of the parts of the instrument are all so slow that the wear is an unimportant consideration. The shaft, B, in making only one revolution in 12 seconds, would produce very little wear, and the shaft, A, is geared down so its motion is not rapid. As already stated, there are nearly 1,700 of these instruments now in use in Europe, and they have been so successful that the owners of the patents on the instrument are now making arrangements to have them made and placed on the market in this country. It is expected that they will be offered at a price so low as to remove all objection to their introduction on that score.—*Railway Review.*

## HOW TO BUILD A COASTING SLED.

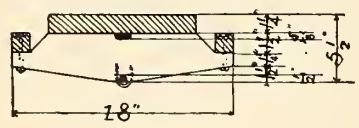
By FRANCIS T. FREELAND, Aspen, Col.

THE danger of coasting may be much lessened by a sled of good construction, provided with a powerful steering gear, brake, gong and lantern, and so designed that the seat is clear of all obstructions, enabling the passengers to roll or slide off, if a necessity arises.

The sled shown is 15 ft. over all, with seat of ash, 14 ft. × 12 × 1¼ in. It tracks 18 in. and stands but scant 10 in. from the ground. Rubber washers separate the seat from the bobs and take up the vibration. The truss rod acts as a spring on account of the rubber washer at one end. The bobs are of oak and lightly braced with riveted iron straps. The steering gear is new. It consists of double purchase blocks, working between the main cross-piece on the bob and the front foot-rest on the seat. When rocking sideways to counteract the centrifugal force developed in turning a




Section EF

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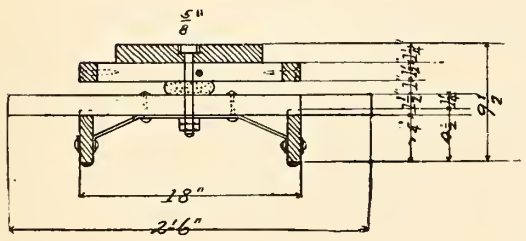



Section AB

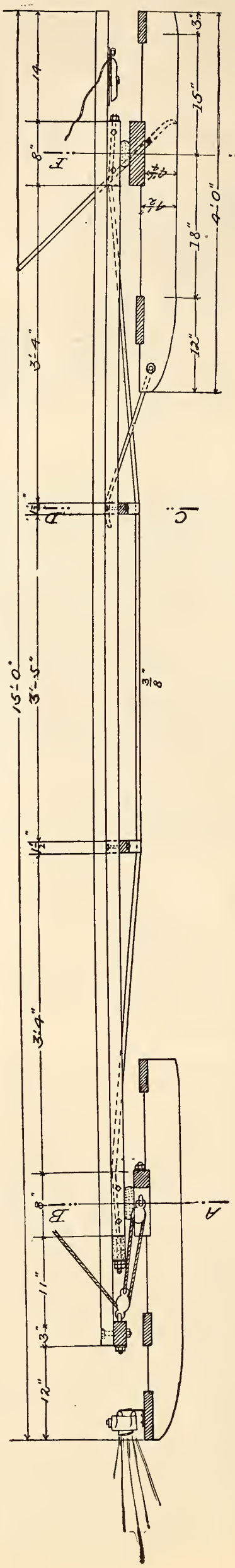
COASTING SLED.

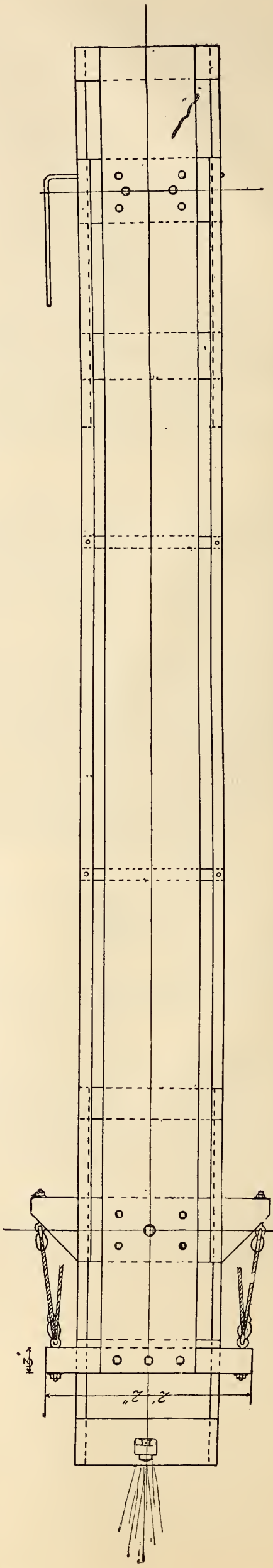
corner, it will be seen that the rope is pulled in a perfectly natural direction. One man can steer this sled with ease with the whole load on. The runners should be narrow for speed on a hard surface, about ½ in., half-round steel, not flat nor oval, and be parallel and set to track in line. The foot rail allows the heel to clear the seat and yet not to jam in the slot. The seat is dressed smooth, but not upholstered. The V-shaped tongue of the back bob is riveted to the runners, and the point plays freely in the back truss-block under the seat. The truss-rod clears the front king-bolt. The rear queen-bolts have a little play. The lantern must be on springs, as in a bicycle, or it will go out. The sled is made as light as possible, about 150 lb., when the load is considered. Two or three men can easily pull it up hill, but for a large party a horse would be useful, as some may wish to ride back.

A good wagon maker and blacksmith can readily construct it, as there is no machine work on it. The cost will be from $25 to $35, according to the location, exclusive of the shelf hardware. The design is not patented.

## ANTHONY RECKENZAUN.

IT is with the deepest regret that we have to record the death of Mr. Anthony Reckenzaun, which took place November 11. The death of Mr. Reckenzaun leaves a gap in the professional ranks of the industry which it will be difficult to fill. He had made himself the English authority on all matters relating to electric traction. We give an account of his career. He was born at Gratz in 1852, and received his early education in that town. Like most successful electrical engineers, Mr. Reckenzaun was originally trained as a mechanical engineer. Coming to England in 1872, he entered the employ of Messrs. Ravenhill & Miller, afterward Messrs. Easton & Anderson. While with Messrs. Easton & Anderson he qualified as a teacher



under the Science and Art Department, and established evening classes for the employes. Subsequently he attended lectures at the School of Mines and at Finsbury. Feeling a great interest in electrical matters, Mr. Reckenzaun made a thorough study of the apparatus at the Paris Exhibition in 1881, then joined the Faure Company, but soon after accepted the position of electrical engineer to the Electrical Power Storage Company. Here he turned his attention to traction, a branch of the industry with which his name has since been intimately connected. Storage batteries were also carefully studied, and their capabilities investigated. In fact, Mr. Reckenzaun perhaps did more than any one to show, by his practical work, and by various papers, the value of storage batteries in all kinds of electrical work. He spent a year or so in America successfully fighting the fight of such batteries. More recently he has been closely allied with the General Electric Company and with Messrs. Greenwood & Batley. Mr. Reckenzaun reached his acknowledged position as one of our foremost experts in batteries and traction because of the painstaking industry and skill with which he investigated every problem connected therewith. Some months since, the lung troubles to which he finally succumbed were felt to be serious; but although then seriously ill, he during the late summer visited America, hoping the change would prove beneficial, as well as desirous of continuing those business relations which he had on that side as well as on this side of the Atlantic. Unfortunately, the hoped-for improvement did not come, and on his return he gradually declined, though hopeful to almost the last. To most of us the loss of this prominent member of the industry means the loss of a personal friend whom we all esteemed, and who was as firm in his friendship as he was able and energetic in his occupation. As will be seen, Mr. Reckenzaun had been engaged in the industry from its rise in 1881, and throughout this period had made a reputation in his particular sphere second to none. His lectures on electric traction to the City Guilds formed the basis of a book on the subject, in which his great knowledge of the subject is fully shown. Recently his mortal remains were consigned to their resting-place in the presence of numerous friends.—*Electrical Engineer, London.*

## THE WAR IN BRAZIL.

THE special correspondent of *The London Times*, who sends the accompanying map of Rio de Janeiro harbor, says that the condition of affairs is a curious anomaly. "There is no blockade of the city of Rio, owing to the action of the powers in protecting foreign shipping, and allowing it to carry on the ordinary commercial business of the port; for the same reason, the insurgents have not turned the guns of the fleet or those of Villegaignon on the town. To-day, there are two kings in Brentford—the legal President, or rather Vice-President, Marshal Floriano Peixoto is king of the land, and Admiral Custodio de Mello is king of the sea, or more correctly, of the harbor and the coast line, for the government forts of Santa Cruz, San Joao and Lage completely command the entrance of the harbor, and render the passage in and out a most difficult and dangerous undertaking for the insurgents. The key of the position is the possession of the forts at the entrance, and yet, for some reason difficult to fathom, the insurgents prefer to devote their energy and waste shot and shell in bombarding Nictheroy, the capital of the State of Rio de Janeiro. Matters cannot continue long as they now are. The two sides growl and bark at one another, but do not bite.

"Some 20,000 shots from different pieces of artillery have been fired and no decided advantage has been gained by either side. The insurgents have lost some 35 men killed, and the government has had about the same number of casualties to record at Nictheroy and Rio. The latter, however, sustained a further serious loss last month when the cruiser Republica rammed the transport Rio Janeiro, conveying troops to Santos. Eleven hundred men were on board the transport, and of these only 600 were saved by the Republica. It must not for a moment be forgotten that the city is completely at the mercy of Admiral Mello, and that at any moment he can lay it in ruins and thus force the resignation of Marshal Peixoto. Admiral Mello has in no way taken advantage of the fact that he has this power, but has met the representations made to him in a most friendly spirit, and has honorably adhered to his promises to the representatives of foreign powers."

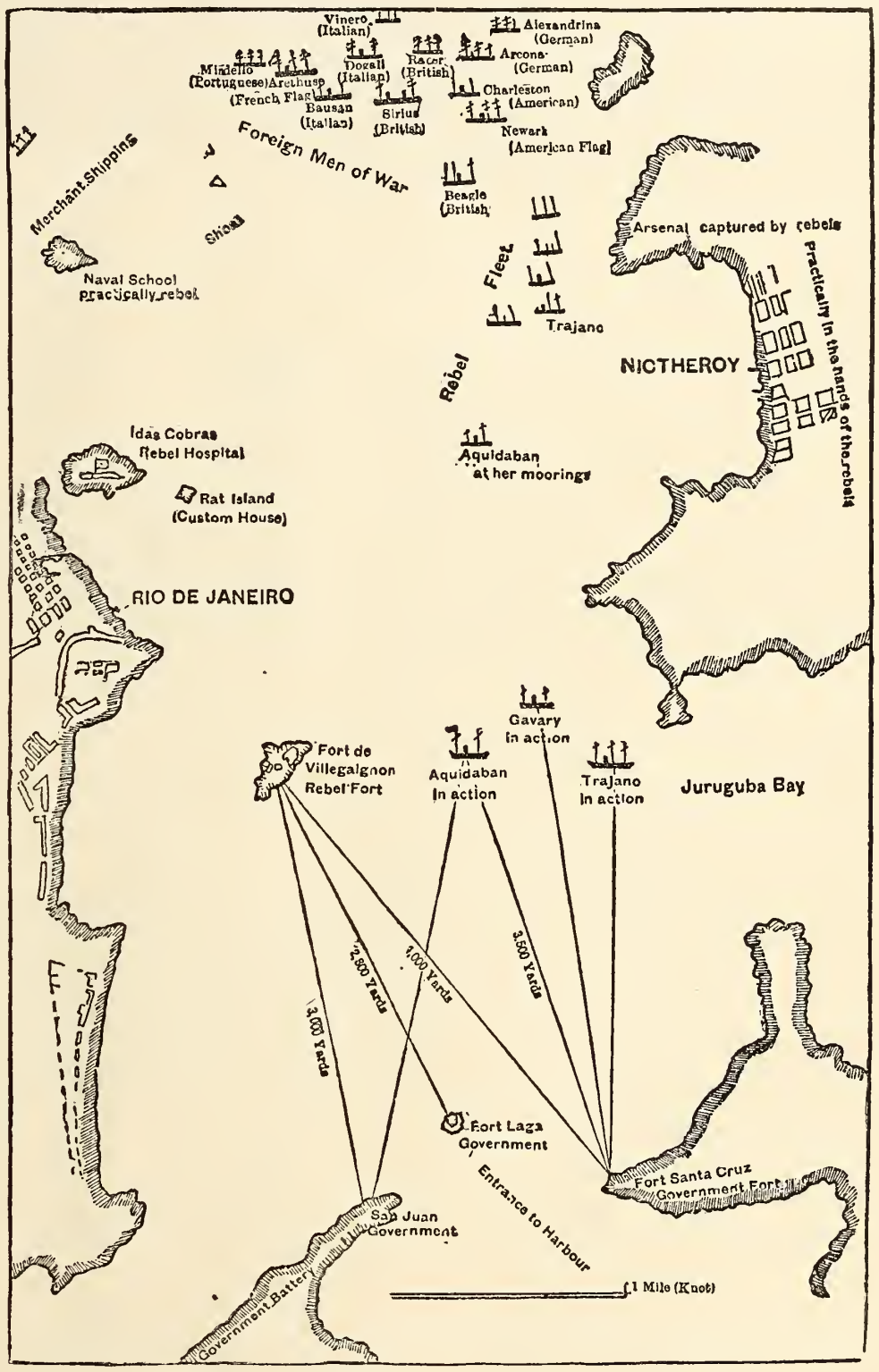
The correspondent proceeds to describe a visit paid by him to the Aquidaban, the flagship of Admiral Mello. "It was no easy matter," he says, "for the pains and penalties are many and various for any person caught in communication with the insurgents. The Aquidaban is not much the worse for all the heavy firing to which she has been exposed. Four shells have gone through the upper deck and burst between decks; another passed through the funnel, and the mizzenmast is half cut away; about a dozen shots have struck her on the sides without doing any damage. Both officers and men appeared cheery and contented. The admiral's secretary showed me the infernal machine that was sent from the shore for the purpose of disposing of the chief of the revolution. It consists of a thick volume entitled 'Consultos do Estado,' with the edges gummed together; the center was hollowed out and a pound weight of dynamite inserted. This was to be fired by a detonator fixed to the cover of the book, and would be exploded by the act of opening the volume. Happily the admiral had his suspicions of what the parcel contained, and so no harm was done. Admiral Mello received me in his usual courteous manner, and was anxious to supply me with all information I wished for. He stated emphatically that his action in the revolution had been taken after mature consideration of the consequences, and that he and his supporters had been forced into it as the only means of making an effectual protest against the military despotism and reckless financial policy that in his opinion characterized the administration of Marshal Peixoto. The admiral stated that the actual cause of matters coming to a head was the arbitrary manner adopted by Peixoto when he placed his veto on the bill providing that no vice-president was eligible for election to the presidency. The President exercised his right of veto on September 5, and on the morning of the 6th the insurrection was declared.

"Admiral Mello declares that the question of a restoration of the empire was never seriously mooted, but that if a majority in a new Congress favored such a movement it rested entirely with themselves to decide for or against it. He appears confident of success, but thinks he could gain his ends more expeditiously if he was recognized as a belligerent and enabled to use freely the rights that such a *status* would confer upon him. Not only does he claim that the provisional government of the United States of Brazil is firmly established at Desterro, the capital of Santa Catarina, but he also claims that the States of Rio Grande do Sul and Paraná are entirely with the insurgents. He states that Captain Lorenzo, the Provisional President, Lieutenant Mourao, Minister of Marine and Acting Minister of Foreign Affairs, and Major Annibal Cardoso, Minister of War and Acting Minister of Public Works and Justice, were all men who had been selected on account of their fitness for the posts they now occupy.

"If the insurgents win the day a general election will be held throughout the country, and it will be made a proviso that a civilian be elected as president. The insurgents are well supplied with ammunition, having seized all the naval warlike stores in the possession of the Brazilian government at the time the revolution broke out. Admiral Mello also stated that he considered he had a sufficiency of money for his purposes."

A telegram received from our correspondent on Wednesday, dispatched by him *via* Montevideo last Friday, shows that the situation has somewhat altered since the above letter was written. The insurgents have captured Fort Lage and are making progress in their movements in the north. Marshal Peixoto is making every preparation for the defense of the city. He states that he intends to fight to the last and that when his ships arrive he anticipates a victory. All business is suffering severely, and there is stagnation in every branch of trade. The financial position of the government has become difficult, the treasury being empty. A heavy artillery fire is kept up between the insurgent and the government batteries, and a good deal of injury has been inflicted. The members of the diplomatic corps consider that it is impossible for them to take further steps for the protection of the lives and property of the foreign residents, and the commanders of the foreign warships agree with them. Admiral de Mello is now inclined to bombard the city after giving 48 hours' notice.

Pernambuco has been declared to be in a stage of siege. This shows a spread in the rebel movement.




RIO HARBOR—DISPOSITION OF SHIPS AND FORTS.

## INTERESTING ARTILLERY EXPERIMENTS AT ELSWICK.

THE great improvements recently made in artillery material by Sir W. G. Armstrong, Mitchell & Company, of the Elswick Works, Newcastle-on-Tyne, were the subject of a close inspection, extending over four days, by the representatives of several of the European powers, the United States and Japan. The inspecting officers were as follows: Colonel Petroff, Chief of the Staff, Bulgaria; Colonel Balabanoff, Director of Artillery, Bulgaria; Colonel Bojaroff, Bulgaria; and Captain Naidenoff, Bulgaria. Captain Henri Lansel, Swiss Attache; Captain Ismail Bey, Turkish Navy; Captain the Chevalier von Jedina, Austrian Naval Attache; Captain Angelesco, Roumanian Artillery; Captain Persico, Italian Attache; Mr. De Vere; Mr. Kunkler; Captain Yendo, Japanese Naval Attache; Lieutenant Yamanouchi, Japanese Navy; Mr. Yamaki and Mr. Matsuo, Japanese Naval Constructors; Captain Noff, Norwegian Artillery; Major Post, United States of America Attache; Captain Munos Hurtado, captain of the Chilean cruiser Blanco Encalada, built at Elswick; Commander Castilho, Brazilian Navy.

These officers arrived at Newcastle on Tuesday evening, November 7th. The 8th and 9th were devoted to an inspection of Elswick Works, and on the 10th and 11th a most elaborate programme of artillery firing was carried out at the range belonging to the company situated at Silloth, in Cumberland. On Wednesday, the 8th, the visitors were shown the methods of construction of various guns, including the system of winding wire or ribbon on the gun, known as the ribbon construction, and it may here be remarked that this construction, which was successfully employed first at Elswick, has lately come into prominence on account of the use of slow-burning powders such as cordite, which, bringing a greater strain on the front portion of the gun, require that portion to be given

extra strength, The visitors were also shown the testing of steel and bronze, and of the large spiral springs which are now so extensively used with the quick-firing ordnance. The cartridge factory created great interest, for there the foreign officers saw all the processes, of drawing out cartridges in operation, but what created the greatest amount of interest was a large exhibit of modern quick-firing guns.

In the English navy the largest gun that deserves the name of quick-firing is a 6 in., but Elswick has just produced a very powerful 8 in. gun which may certainly be termed quick-firing, although no cartridge case is used with it, the obturation being performed by a modified De Bange obturator. To exhibit this gun a crew of five men were in attendance, and went through the drill. Some shot had had their driving bands turned off, and thus prepared, they were placed in the gun and pushed forward into the bore each time that the operation of loading was gone through. The drill, therefore, very accurately imitated actual practice, and yet the crew were able to go through the motions of firing three rounds in the very short interval of thirty seconds, and it should be observed that the present service 8 in. gun, which is a far less powerful weapon, could not possibly fire more than one round per minute. But not only is the new 8 in. gun so rapid in firing, but it is also extremely easy to work; one man trains, elevates, and fires the gun just as if it was a small gun of 4·7 in. caliber, and he does it with perfect ease, although the gun weighs 19 tons and the total revolving weight amounts to 33 tons. Passing from the 8 in. gun, the visitors were shown a similar trial with 6 in. and 4·7 in. guns, the crew going through the motions of firing four rounds from the 6 in. gun in twenty seconds, and seven rounds from the 4·7 in. in twenty-five seconds. Practice from an aiming tube out of a 4·7 in. gun at a target completed Wednesday's programme.

The programme on Thursday, November 9, commenced with the inspection of the steel works department, where the visitors were shown forgings worked under large hydraulic presses, the biggest of which can exert a pressure of no less than 4,500 tons. In the afternoon the first thing shown was one of the new torpedo guns. A trough had been erected in one of the long shops at Elswick, and a dummy torpedo was actually fired in this trough. The special feature of the torpedo tube, which is the outcome of a long series of experiments carried out at Elswick, are that by using cordite as a propellant a high velocity of wonderful regularity is obtained, and this with an entire absence of smoke or fouling. Having completed the inspection of the remainder of the works, Elswick shipyard was reached; here the visitors were shown the powerful Chilean cruiser Blanco Encalada, which has just been finished, and which is one of the fast cruisers of which Elswick has made so great a specialty. The Japanese cruiser the Yoshino is still in English waters, and it will be remembered that this vessel attained a speed of no less than 23·1 knots, the highest speed ever reached by an ocean-going vessel. Another vessel of the same class, that is to exceed all previous ships in speed, was shown to the visitors on the building slip.

By the time the inspection of the shipyard was completed it had begun to grow dark, and advantage of this was taken to exhibit a search light mounted on a steady platform, an arrangement recently invented by Mr. Beauchamp Tower. This novelty proved one of very great interest. The apparatus was placed aboard a small vessel and a beam of light was fixed on an object in the water. The vessel was then violently rolled, but in spite of this the beam of light remained as steadily fixed as if the search light had been secured to the jetty. To give the visitors an idea of the advantages gained by this apparatus, it was then thrown out of gear, and the search light became an ordinary fitting. It was immediately seen that in its then condition it had become perfectly useless while the boat was rolling, for it was impossible to keep the beam of light on any object for a moment.

On November 10 a special train left Newcastle central station at 7:30 and conveyed the party of officers to Silloth, where they arrived at 10. The first gun shown was a large 10 in. 30 ton gun, fitted with automatic breech mechanism. When this gun is fired the recoil energy is utilized for opening the breech screw, and for compressing a spring which is capable of closing it again; there is therefore no delay in opening the breech after the gun is fired, and as soon as the loading is completed it is only necessary to pull a small lever for the breech to automatically close itself. The advantage of this mechanism is apparent, for by its means a great increase can be obtained in the rapidity of loading. Three rounds were fired from the 10 in. gun, and the visitors were immensely impressed with the easy but rapid motions of the breech mechanism. A howitzer on a new mounting, designed for use in the field, was next shown. The peculiarities of this howitzer—which has a caliber of 4·7 in. and fires a shot weighing 40 lb.—is that the carriage automatically anchors itself, and the piece recoils within a jacket surrounding it. Several rounds were fired from this howitzer, used both for direct fire and for high-angle fire. The importance of such a weapon cannot be too much appreciated.

It is well known that some of the military powers of Europe have already adopted howitzers for field ordnance, and it is contended by Elswick that the howitzer exhibited has marked improvements on any previously constructed. A somewhat similar method of anchoring the carriage and absorbing the energy of recoil, by means of an hydraulic recoil press, was next shown, with a 15 pounder field gun. This field gun is also a quick-firing gun using cartridge cases, the breech of which is opened by a single motion of the lever. Several rounds of shrapnel and segment were fired at a target to show the accuracy of which the gun was capable, and to exhibit the anchoring and recoil arrangements. It was found that after the first round, which is used to set the anchor into the ground, the recoil only amounted to 8 in. Five rounds fired with shrapnel for rapidity, the gun requiring but little adjustment at each round, were completed in 53 seconds. The effect was exceedingly pretty, for scarcely did one shrapnel burst and scatter its bullets all round the target but that another followed its example, the target being 1,000 yards distant. Although this gun throws a shell weighing 15 lb., so well has the weight of every part been considered that the total of the whole equipment, with the limber loaded with thirty six rounds, only amounts to 32 cwt., and it must be recollected that a considerable addition has to be allowed for the cartridge cases.

Other field guns followed, showing various systems of brakes and of obturation. These included one gun of 90 mm. and one of 76 mm. A fifteen pounder mountain screw howitzer was also shown, and created as much interest as anything else on the programme. When the visitors were brought up to the gun it was lying in two pieces, just as it would have been taken off the backs of the mules which are supposed to carry it. In five minutes the gun was screwed together, and on its carriage, and ready for firing. Both shrapnel and segment shell were used, and the practice at a target 1,500 yards distant was greeted with loud applause. A 6 in. gun, on a light portable disappearing mounting, was shown in position behind a parapet which had been purposely erected. This mounting is specially designed for transport in the siege train, and it can readily be taken to pieces, so that the heaviest load does not exceed three tons, and yet it can be readily erected, the time required, if plenty of labor is available, being about ten hours. The erection could therefore take place during the night. Several rounds were fired from this gun, and each time the recoil brought it down into loading position with a wonderful precision and ease. The mounting is on the spring principle, that is to say, the gun is raised again after loading by means of a strong spiral spring; there is thus no air pressure system about it, and every part is so simple that it seems impossible that it should get out of order.

It should also be remarked that the range at Silloth being on loose sand, the most trying conditions possible are imposed upon guns and mountings that are experimented with there. The visitors were next shown firing from a 6 in. naval quick-firing gun on a new mounting, the principal object of this trial being to show the great ease with which the mounting could be manipulated. Five rounds were fired, each round being at a different range and at a different target, so that not only had the sights to be corrected after each round, but the elevation and a considerable training had also to be gone through. In spite of this the five rounds were fired in 69 seconds, and most excellent practice was made. A 4·7 in. gun on a pedestal mounting was then fired for rapidity, the shots all being directed at a target 1,000 yards distant. The total time of firing these five rounds was only twenty-two seconds, and so good was the practice that at the second shot the target, which only consisted of a cask with a flagstaff on it, was knocked to pieces. It should also be observed that this 4·7 in. gun was of a much more powerful type than those used in the British Navy, the velocity obtained from it being 2,500 ft., against 2,150 ft. from the English gun. A 4 in. 30 pounder gun was then shown. This gun and mounting possess several peculiarities, the principal of which is that the keys which guide the gun during recoil are on the sides instead of on the top and bottom. The advantage of the new position lies in rendering the top of the cradle unnecessary, and better protection is given to the keys. The gun and mounting are protected by a shield 4½ in. in thickness, and the sighting is done over the top of the shield in such a manner that the firer has always got an all-round view.

Aiming practice was carried on from this gun at a target 2,000 yards distant, and each shot was pitched within a few yards of the target. A new pattern of aiming tube to be used with these naval quick-firing guns was then shown to the visitors, who were much pleased with its extreme simplicity, and who entertained themselves for some time in firing at a target erected for the purpose. With the 6 in. gun an aiming tube firing a 1 lb. projectile was used, and with the 4·7 in. an aiming tube firing Martini-Henry ammunition. A trial of great interest was then carried out against a special steel plate manufactured by Elswick. The plate tried was of 0·223 in. thickness, designed for use for shields of small guns, especially when those guns form part of the armament of vessels, such as torpedo catchers, where weight is of great consideration. To exhibit the properties of the plate, another plate of similar thickness, but of ordinary steel, was also fired at. The trials the plates were subjected to consisted of ten rounds from a magazine rifle and 160 rounds from a Gatling gun. The dimensions of the plates were only 2 ft. by 1 ft. 6 in.; the range was 100 yards. In each case every shot was put on the plate, and although the firing was normal not a single bullet got through the special plate. On the other hand, with the ordinary plate, every bullet from the magazine rifle penetrated, and the stream from the Gatling gun practically cut it in two.

During the experiments a new naval range finder, invented by Messrs. Barr & Stroud, was exhibited, and during the intervals between the firings the visitors amused themselves by taking the distances of all the surrounding objects. The ease with which the instrument was understood and manipulated was most remarkable, and the visitors were fairly astounded by the accuracy of these readings.—*The Engineer, London.*

## FERMENTATION.

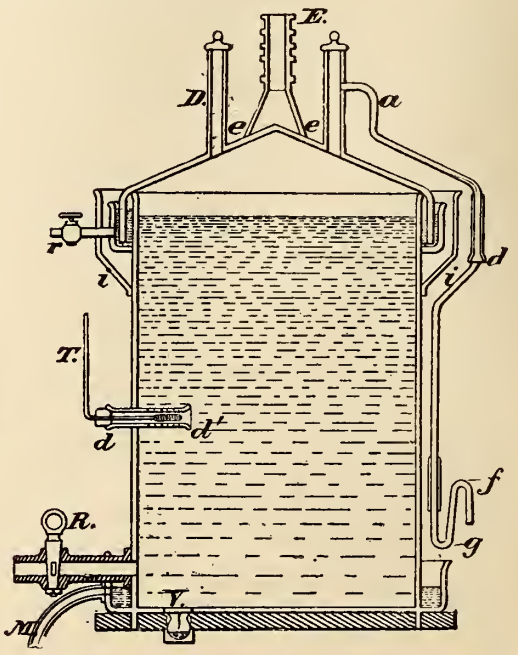
By C. C. STAUFFER.

FERMENTATION is an effect concomitant with a large number of biological processes. The acts of mastication and digestion, the germination of seeds, the formation of cheese, the decay of all tissues, whether living or dead, the formation of wine, beer and vinegar, are some of the processes which are due, in whole or in part, to the growth of micro-organisms, which may be broadly defined as ferments. There is, at first sight, a wide difference between the dreaded cholera bacillus and the familiar yeast germ of all brewing establishments, but they are both minute forms of life whose modes of existence and of propagation are, in many respects, similar. This article, however, has to do with the ferments used in the production of wine and beer and the apparatus by means of which they can most readily be made to produce a desired result.

In the ordinary mode of making beer, two ferments, or rather ferments of two kinds, are employed. The first of these are the soluble or diastatic ferments or enzymes, which serve to convert the raw grain into fermentable substances during the process of malting, and are characterized as four, viz., diastase, invertase, peptase and cytase. These all have distinctive functions, the diastase acting upon the starch of the grain to convert it into the sugar called maltose, the invertase having the power of converting any cane sugar present, which is not fermentable, into dextrose and levulose which are fermentable, the peptase serving to convert the albuminoids into peptones, leucin and tyrosin, and the cytase serving to bring about the dissolution of the walls of the starch cells and thus render the starch more accessible to the diastase.

The effect of the soluble ferments is, however, simply to prepare the raw material for the action of the true ferments or yeasts, which belong to another class. The ferments which are apt to exert an influence upon the wort during the process of fermentation are of three genera, viz., the saccharomycetes, or yeasts, the schizomycetes, or bacteria, and the hyphomycetes, or moulds. Among the bacteria is included the butyric ferment which is the dreaded cause of the so-called "sickness" in beer. As might be imagined, both the bacteria and the moulds are injurious and are to be avoided as much as possible. The patents referred to below have special reference to the exclusion of all harmful organisms and the encouragement of the growth of the true yeasts. The nature of the resulting beverage depends mainly upon two factors, the material employed and the character of the yeast with which it is set. These are, of course, more or less modified by conditions of temperature and pressure. It is necessary to consider yeast as a plant of which there are a number of species and capable, when placed in a suitable environment, of growth and reproduction with a concomitant breaking up of the sugar and albuminoids present into ethyl and other alcohols and carbon dioxide. Of the several species of yeast, the *Saccharomyces cerevisiæ* is the one chiefly employed in the production of malt liquors and the *Saccharomyces ellipsoideus* is the main ferment of fruit juices and wines. Besides the ones mentioned, there are a number of others which are apt to be present to some extent, some of which are known as wild yeasts. The wild yeasts are injurious equally with the bacteria and moulds. The effect of all these is the production of bitter, acid or otherwise badly tasting substances. As a rule, however, the conditions of temperature and environment which are favorable to the thorough and rapid production of yeast of one kind hinder the production of others. Hence these injurious bodies lie dormant until a suitable time and temperature occur. This fact is of importance when we remember that commercial yeast is a mixture of several saccharomycetes, the normal yeast (*cerevisiæ*), of course, largely predominating. Other varieties are abundant, however, and it is upon the presence and character of some of these that the differences in flavor of fermented liquors, in a large measure, depend. The brewer's difficulty lies generally with the wild yeasts and the bacteria present.

The nature and essential characteristics of yeast were first made clear by Pasteur, and his researches have been followed up and supplemented by many other savants, among whom Dr. E. Chr. Hansen, of Denmark, is one of the foremost. Pasteur was the first to point out the relation between pure yeast and good products, and the practical application of his conclusions in many breweries throughout Europe led to a general and rapid improvement in the character of their products. One means employed by him for the isolation of pure yeast germs and the subsequent propagation of yeast of a definite character is shown in the accompanying figure, which is taken from his United States patent, No. 141,072.




PASTEUR'S DEVICE.

He takes impure yeast and causes it to act on a solution of sugar candy in pure water. When the fermentation is terminated, he decants the fermented liquid and adds a fresh quantity of sugared water on the top of the yeast deposit. This operation is repeated two or three times, more or less, according to circumstances. He then takes a shallow porcelain dish, first dipping it in boiling water, and puts in it a little beer wort which has been recently boiled or preserved by the Appert process. He then dilutes a little of the yeast deposit of the above described fermentation in the wort, and covers it with a glass plate. The yeast, which has become more or less exhausted by its action on the sugared water, will then rise and rapidly revive, purified of all germs of disease.

This treatment may be repeated by diluting a little of the yeast deposited at the bottom of the first dish in some fresh wort.

The degree of purity of the yeast may be ascertained with the aid of a microscope, which will indicate the presence of the germs, and show whether, by means of the yeast, a beer may be produced which shall not vary in condition at any temperature.

The apparatus consists of a cylindrical vessel, closed by a cover, the rim of which dips into a water trough around the top of the vessel, provided with a cock, *r*. The beer wort, properly so called, or other wort used in beer making, is first boiled in the copper, and then poured into the cylinder, which is completely filled, and the cover put on. Then, by means of a rubber tube, *c d*, the metal pipe, *a c*, opening into a stoppered pipe rising from the cover, is connected with the tube, *d c f g*. Boiling water is then poured on the cover and on the pipes rising therefrom, which fills the trough, the overflow passing into a gutter, *i i*, from which the water escapes through a slit or a number of small holes in the bottom, and is collected in another gutter at the bottom of the cylinder, provided with a discharge pipe, M.

T is a bent thermometer, for indicating the temperature of the wort, the bulb of which is protected by a perforated guard, *d' d'*. R V are cocks or apertures for discharging the liquid and sediment from the cylinder.

The cylinder thus filled is allowed to cool by contact of the external air, afterward assisted, if necessary, by cold water introduced at pipe E on the cover, which passes through apertures, *e e*, and trickles down over the cylinder. Air enters the long tube, *g c f d c a*. The yeast is then introduced through the pipe, D, which is immediately closed, the carbonic acid produced during the fermentation passing off at tube *f g*.

A tube similar to *a c d c f g* may be adapted to pipe, D, of a different length, if desired, for the escape of the carbonic acid gas, while a limited quantity of air is admitted by the other tube.

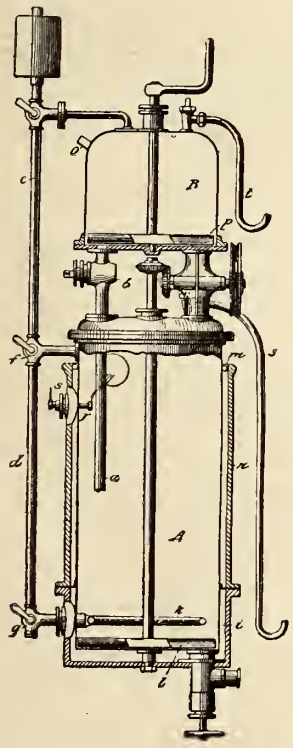
The wort may be readily cooled in presence of carbonic acid gas by introducing the latter beneath the cover during the cooling.

The tube, *f g*, may terminate by a loose plug of asbestos or cotton, or by a metal tube heated during the admission of the air. A drop of liquid in bend *g* will serve to indicate the movements of the gases.

It should be borne in mind, however, that several species of yeast are so closely allied to each other and so nearly of the same form that they can only be distinguished by a careful study of their effects. The method just described would not therefore suffice in all cases.

Another later and somewhat improved apparatus is that shown in the following illustration, which is taken from the United States patent to Jorgensen & Bergh, No. 467,993. This device is especially designed for use in carrying out some of Hansen's ideas. The operation is as follows:

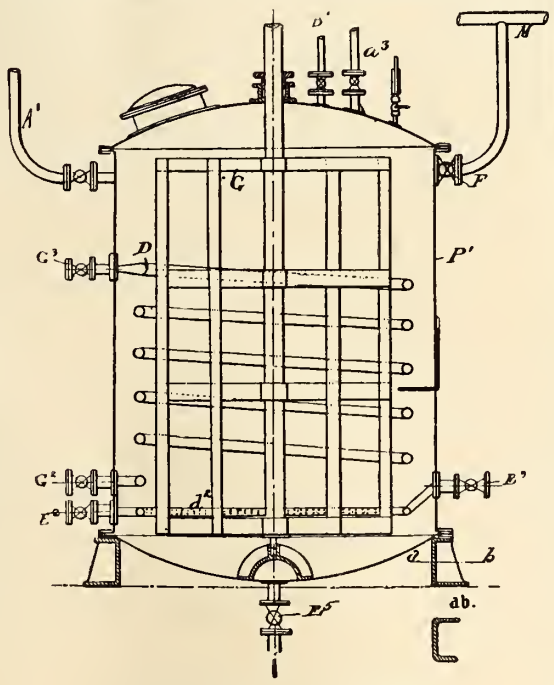
Sterilized air can be conducted through an air filter, C, and thence through two pipes, *c* and *d*, and three



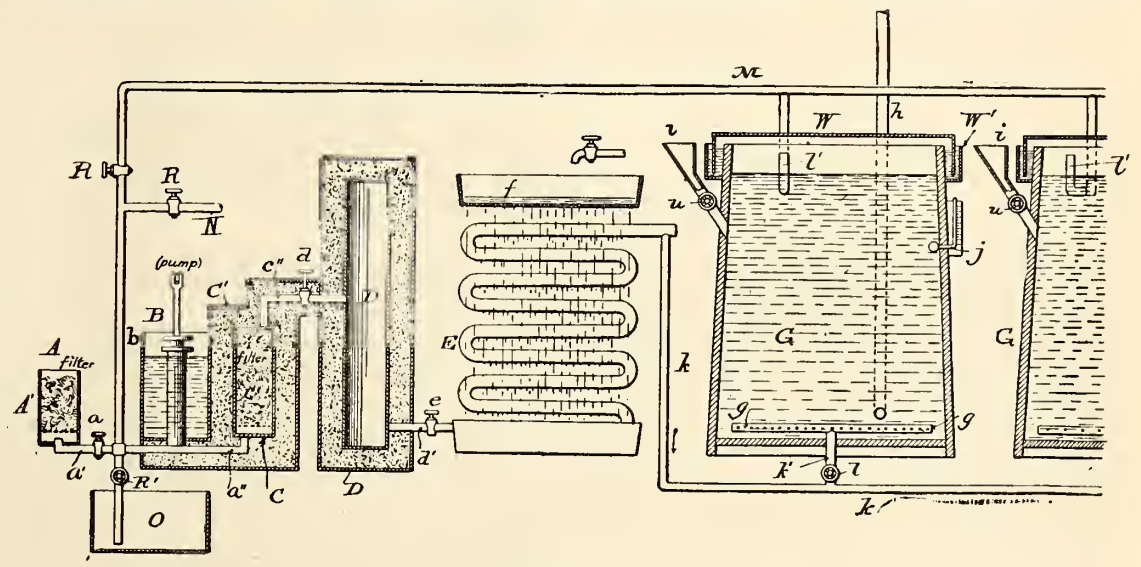
A. JORGENSEN & A. BERGH, 1892.

cocks, *e*, *f*, and *g*, to both cylinders. The wort is preferably introduced in the sterilized state into the lower cylinder, A, directly from the brewery, or it may be sterilized in the same cylinder by admitting steam to a chamber, *i*, at the lower part of a casing which surrounds the aforesaid cylinders. After the desired quantity of wort has been admitted the air is introduced in a suitable manner. For this purpose the third or lower of the above-mentioned cocks, *g*, communicates with a pipe, *k*, which is arranged in the lower cylinder at a short distance from the bottom of the same, this pipe being closed at one end and provided with small holes at the inner and outer sides. The three cocks, *e*, *f*, and *g*, are so placed that the air is forced through the filter, C, directly into the said pipe, *k*, from which it issues on both sides. At the same time an agitator, *l*, which is preferably made of helical form and arranged as closely as possible to the bottom and sides of the lower cylinder, A, is caused to rotate for the purpose of stirring the wort. The cooling is effected by causing cold water to pass from an annular pipe, *m*, surrounding the upper part of the said cylinder along the outer periphery of the latter, or to circulate either in the chamber, *n*, at the lower part of the latter casing round the cylinder or in the entire casing. A quantity of the aerated and cooled wort is forced by air pressure into the upper cylinder, B, which is sterilized by steam or in any other suitable manner. Absolutely pure yeast produced in the laboratory is introduced through a pipe, *o*, into the upper cylinder and is intimately mixed with the wort by means of the helical agitator, *p*, arranged at the bottom of this cylinder. In order to enable the quantity of wort which has been introduced into the lower cylinder and forced upward into the upper cylinder to be indicated without the use of a gauge glass, a float, *r*, is connected by means of an arm to a spindle, *s*, which extends to the outside of the cylinder and carries a hand which indicates the level of the liquid in the said cylinder, A. When the yeast has been intimately mixed with the wort in the upper cylinder, B, the charged wort can be caused to pass through the above mentioned cock, *b*, and pipe, *a*, back to the lower cylinder, A, either at once or after it has been allowed to ferment in the upper cylinder. After the wort contained in the lower cylinder, A, has likewise been started and the yeast has been properly mixed with the same, a definite quantity is forced into the upper cylinder, B. The charged wort and both cylinders must be kept at a temperature adapted for the continuation of fermentation. As this apparatus has for its object to produce pure yeast for use on a large scale, it is a matter of course that this yeast can be removed either when the fermentation has reached its highest stage or after the yeast formed has fallen to the bottom of the cylinder. In the former case the entire mass is stirred on the third or fourth day of the fermentation by means of the above mentioned agitator, *l*, and is then removed and added to the wort in a large fermenting vessel. In the latter case the beer standing over the yeast is let off through the pipe, *k*, near the bottom of the cylinder and the lower of the three cocks, *g*, as the said pipe, *k*, occupies such a position that enough beer will remain in the cylinder to keep the sediment sufficiently liquid for removal. The superfluous air and the carbonic acid produced escape through two bent pipes, *t* and *u*, connected with the upper and lower cylinder. In either of these cases a sufficient quantity of fermenting wort must be forced beforehand into the upper cylinder, B, for enabling a fresh fermentation to be subsequently commenced therewith in the lower cylinder, A. When the yeast has been removed, the lower cylinder, A, is cleaned and sterilized. The wort is introduced in the manner described and treated with the yeast formed in the upper cylinder, B, under similar conditions, where upon the upper cylinder, B, is cleaned and sterilized. This operation is repeated every time.

Another and more complicated device is that of Guignard, described in United States patent No. 471,335. This has for its objects the sterilization and cooling of the wort, the introduction of pure yeast, the perfect sterilization of the air necessary to the growth of the yeast and the introduction of the pure yeast growth into sterilized flasks without exposure to contagion.



G. GUIGNARD'S DEVICE.



C. F. LAWTON'S DEVICE.

The fermenting vat which he employs is here shown in section.

All the cocks being turned on, the apparatus is sterilized by a current of superheated steam, which is led through the cock, $E^2$, during about twenty minutes at a temperature of about 120° Centigrade after the exit of all the air. Thereupon the apparatus is cooled and the steam inlet, $E^2$, is closed, and the cock in pipe, A, is opened to admit the worts from the cooler. During the fermentation the steam inlet, $E^2$, is closed and cock, $E^3$, is opened to admit sterilized air, which is forced under pressure through the mass in the vat, thereby greatly increasing and expediting the production of the yeast. B' is an escape cock for the air or steam, and is closed when the fermentation begins, at which time the cock, F, is opened, and through it the carbonic acid and water generated in the vat pass into a general piping, M, the end of which may be submerged in an antiseptic liquor—such, for example, as a solution of corrosive sublimate. By this means unsterilized air is prevented from flowing back. The cock, $a^3$, is used to control the admission of sterilized air at the top of the vat to aid in the expulsion of the matters therein by the exit pipe at the bottom controlled by cock, $E^5$. G is an agitator.

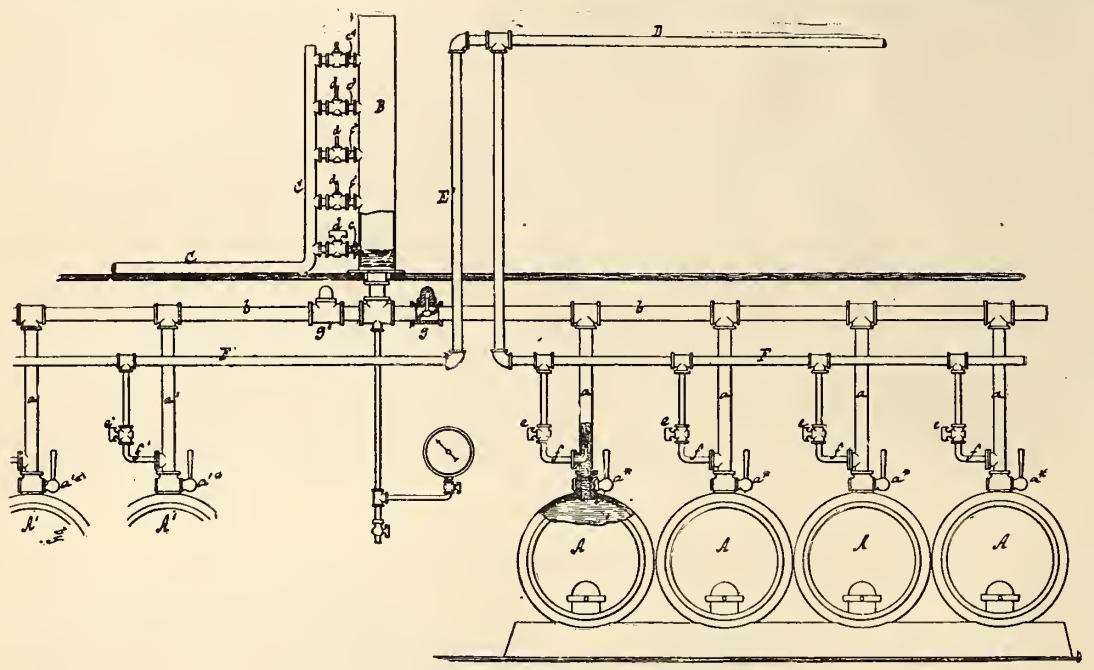
The accompanying cut is taken from the patent to Lawton, No. 468,809. The apparatus is used for the purpose of preventing the introduction into the wort of deleterious ferments and bacteria from the air while it is subjected to the proper yeast ferment. This result is effected in a rather unique manner. The hot wort is run into the tuns, G, through funnel, *i*, or pipe, *h*, and the covers, *w*, put on while the liquid is still hot and sealed by the antiseptic liquid in the trough, W'.

Air is then forced by pump, B, through filters, A and C, reservoir, D, and cooling coil, E. The filter, A, removes the mechanical impurities from the air. The filter, C, is packed with sand or compressed asbestos, and this filter, as well as reservoir, D, are surrounded by a non-conducting packing or covering. The air being drawn in by the pump more rapidly than it can escape into the fermenting tuns through the cocks, *l*, which are opened but a little way, is condensed and heated in filter, C, and chamber, D, to a temperature sufficiently high to kill all the germs which it may contain. It is subsequently cooled at E. This device may be used to cool the wort, as well as to supply the air requisite for fermentation. The carbon dioxide produced by the fermentation is drawn off at O. The pipe, N, may be used to charge the liquid with another gas, if desired.

The foregoing patents have dealt mainly with the purification of yeast, wort or air. There are, however, other conditions which sometimes maintain and which may modify the result to some extent. The alteration of atmospheric pressure is one of these. The first suggestion of this kind to be set forth in any patent is that disclosed in a patent to Sheridan as early as 1837 (No. 245). In this it is said that the pressure is maintained during fermentation at from 15 to 20 inches of mercury, the latter pressure being used in the last 24 hours of the process. The patentee asserts that this diminution of pressure prevents the development of the acetous ferment, but it is somewhat doubtful whether his assertion can be maintained. It is probable that the development of this ferment is prevented in the usual way—that is, by keeping down the temperature. In British patent, No. 4,746, of 1890, it is asserted that "in highly rarefied spaces the efficacy of yeast as an exciter of fermentation is far more energetic and productive than in non-rarefied spaces, and the quantity of yeast necessary for a given purpose is greatly reduced. . . . In the case of bakers' goods, about 50 per cent. less yeast than is usual may be employed," if the pressure be greatly diminished. The two cases last referred to are to be contrasted with that of Lawton's, alluded to above, in whose apparatus the pressure must always be, to a slight extent, at least, greater than that of the atmosphere. This is also true of the apparatus used by Jorgensen and Bergh, as well as of that used by Guignard. The device of Pfaudler, patent No. 293,909, illustrated is one in which it is especially intended that the pressure shall be greater than that of the atmosphere. The patentee has, however, failed to point out any advantage to be derived from this increase of pressure during fermentation.

In this drawing the letters A A A represent a series of fermenting vessels or casks, which are connected by pipes, *a a a* (which I term the "hydrostatic" pipes), to a pipe, *b*, which extends from the bottom of a vertical tube, B. This tube is filled with water or other liquid, and it is provided with a series of nozzles, *c c' c² c³ c⁴*, which communicate with a common discharge pipe, C. Each of the nozzles is provided with a stop cock, *d*, and if the nozzle, *c*, is opened the liquid in the tube, B, sinks down to the level of this nozzle; but if this nozzle is closed and the second nozzle, *c'*, is

opened, the liquid in the tube, B, sinks down to the level of this second nozzle, $c'$, and so on. If the casks, A A A, are filled with beer or other fermentable liquid, and the stop cocks, $a^*$, in the hydrostatic pipes, $a\ a\ a$, are opened, the liquid in the casks is exposed to the pressure of a column of liquid, the height of which can be regulated by means of the nozzles, $c\ c'\ c^2\ c^3\ c^4$. I place the tube, B, at such a level above the casks, A A A, that if the nozzle, $c$, is open the liquid in the casks is

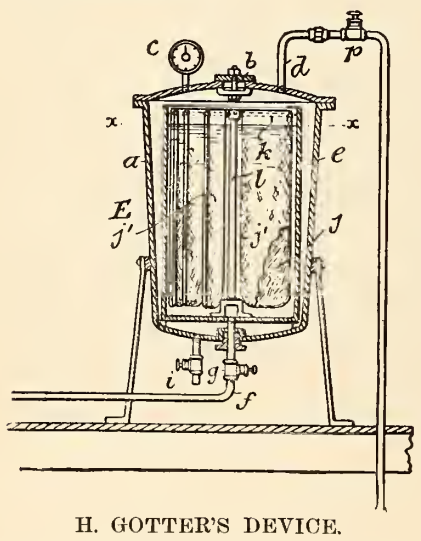


C. PFAUDLER'S DEVICE.

exposed to a pressure of, say, five pounds to the square inch. If the nozzle $c'$ is open, the pressure is increased to, say, six pounds to the square inch, and so on.

D is a water supply pipe, the water supplied by this pipe being under a pressure of, say, fifteen pounds or more to the square inch. This water supply pipe connects by a vertical pipe, E. with a horizontal pipe, F, from which extend a series of spouts, $f$, one into each of the hydrostatic pipes, $a$. The spouts, $f$, are provided with stop cocks, $e$, and when these stop cocks are opened jets of water are injected in an upward direction into the pipes, $a$, and the water thus injected flows off through the open nozzle ($c$, for instance) in the tube, B. The stop cocks, $e$, also serve to regulate the force of the jets injected into the pipes, $a$, and they are only opened just far enough to enable said jets to produce an upward current of the requisite force. The liquid in all the casks, therefore, is held under a hydrostatic pressure of, say, five pounds to the square inch if the nozzle, $c$, is open, or six pounds to the square inch if the nozzle, $c'$, is open, and so on, as will be readily understood from the foregoing description. The barm, as it forms from the fermenting mass contained in the casks, A A A, enters the hydrostatic pipes, $a\ a\ a$, and by the upward currents produced by the jets injected through the spouts, $f$, such barm is carried off into the tube, B, when it flows off through the open nozzle, $c$ or $c'$, as the case may be, and through the discharge pipe C.

Fermentation under pressure is also a feature of the Gotter patent shown below.



H. GOTTER'S DEVICE.

The fermenting vessel, E, is illustrated as containing spun glass, $j$, as the material immersed in the wine while undergoing fermentation. In order that this spun glass shall be distributed in all parts of the vat, it is placed in bags, $j'$, of suitable material, which are suspended from the rods, $k$, radiating from a central standard, $l$. Obviously, this supporting mechanism may be varied—for instance, silver wire may be used—the object in view being to distribute the substance, whatever it may be, in various parts of the vat.

It is obvious that the more evenly and thoroughly the yeast is maintained in a state of distribution throughout the liquid, the more rapid and complete the fermentation will be. The maintenance of this state of distribution is the design of a patent to Gotter, No. 443,190. He fills the fermenting vessel, E, with spun glass in sheets and with the barm or yeast thoroughly distributed through these sheets. This keeps the yeast from rising to the top or settling to the bottom of the wort, as in ordinary top or bottom fermentation.

Other means have been used by other patentees, as paper, cotton, flax, hemp, chopped hay, fiber, pulp, sawdust, fruit skins, etc., by Reihlen (patent No. 301,006), and animal fiber, especially wool, by Meyer (patent No. 467,308), both of whom state that peculiar advantages result from the use of their respective materials.

The foregoing patents have been selected with especial reference to their relation with the mechanical features involved in the process of fermentation. There are many patents which deal with the chemical features of the subject, some of which may be discussed in a future article.

## THE DENSITY OF THE EARTH.

By HENRY WURTZ, Ph.D.

To the five figures that we have heretofore had for the mean specific gravity of the planet we live upon—the outcome of five distinct sets of experiments—there has been recently added a sixth, by Alphonse Berget. His new figure is now one of three which agree even better than should be expected from such delicate and difficult work as the weighing of a globe 24,000 miles in circumference. Yet we appear now to have figures inspiring much confidence. Berget's method was by measuring the relative attraction upon a "hydrogen gravimeter" of a lake of 100 acres surface, in the province of Luxemburg, Belgium, at its highest and lowest points, varying in level about a foot and a half. The mass of water was, therefore, 6,534,000 cubic feet; and weighed 2,721,411 tons. His earth density determination was 5·41.

One method used by Maskelyne at Mt. Schiehallion, near the Tay, in Perthshire, Scotland—also by Col. James, at Arthur's Seat, near Edinburgh—was based on the divergence from the exact radial direction of a plumb line produced by the attraction of the mountain. It is therefore subject to errors in the determination of the mass of the mountain. Col. James' figures led to a density = 5·316, the smallest of the six here discussed. Professor Airy, the British Astronomer Royal, made many attempts, at first unsuccessful, to obtain figures in another way, by establishing duplicate pendulums, at the surfaces and bottoms of deep coal mines. He succeeded, in 1854, at a mine 1,260 feet deep. He here found an acceleration of the lower pendulum of but 2¼ seconds per 24 hours. From this he computed for the density 6·565, the highest figure on record, and probably higher than the truth by more than a unit. Cavendish measured the attraction of two spheres of lead weighing 174 lb. each upon two leaden balls of one hundredth part this weight, suspended in a torsion frame. The amount of torsion was measured through a telescope, first producing the torsion in one direction, then in the other. He obtained 5·48, which is one of the three best concurrent figures. The third was obtained by Reich, by a method which the writer cannot now refer to.

The six figures alluded to are as follows:

| | | |
|---|---|---|
| No. 1. Col. James | 5·316 | |
| " 2. Berget | 5·41 | } Mean of 3 = 5·443 |
| " 3. Cavendish | 5·438 | |
| " 4. Reich | 5·48 | |
| " 5. Baily | 5·66 | |
| " 6. Prof. Airy | 6·565 | |
| Mean of all | = 5·645 | |
| Mean of 1 to 5 | = 5·461 | |

The method of Cavendish is, to judge from these few figures, the most likely to lead in the path of success. Instead of six, however, we ought to have a hundred determinations made under all possible variations of the conditions.

No one will doubt, however, that the three figures, Nos. 2, 3 and 4, giving us the mean 5·44, must be approximations to the true mean density of our globe. It follows that the average density of all the materials of the sixteen miles of the earth's crust that we know geologically is less than half the mean density.

Moreover, the average of the materials thrown out by volcanoes—believed by geologists generally to come from several hundred (some say 800, others 1,000) miles below the surface—is also less than half the above mean. The conclusion then follows that the average mass of the globe, below the sphere of volcanic action, must be very greatly heavier than the mean, and we shall not exaggerate in assuming that it may be higher than 10 (water being =1). For if we compute the volumes of spheres of 8,000 miles and 6,000 miles in diameter, according to Hennessy's mathematical investigations, we find the former to be 268,083,200,000 cubic miles, while the latter is only 113,097,600,000 cubic miles, much less than half the whole. Even if we take off a shell of but 800 miles, as Mr. Hopkins has mathematically deduced for the thickness of the crust, from the precession of the equinoxes—which gives us an inner sphere of 6,400 miles in diameter—we find for this latter the volume 137,258,598,400 cubic miles, which is little more than half the whole volume of the earth. The writer believes, therefore, that we are entirely justified in assuming a density even greater than ten times the weight of water for this inner nucleus of the earth, below the solid stony crust, of the deeper portions of which volcanic eruptions furnish us samples.

This slight discussion has now led us directly to a stupendous question. What is it that we have in this inner half of our globe? Geologists of the highest class are apparently mainly agreeing of late years in the view that this internal nucleus must be a *solid* mass and not liquefied by heat, as formerly imagined. We get no decisive solution of this great question from the materials we find in the outer portions of the crust or from what volcanoes send us of the inner portions. The loose assumption has been long since made, and is often reiterated, that this problem is fully solved by an absence of oxygen in this internal nucleus, and that the *metals* found in the outer crust being, therefore, in their elemental state, are, of course, heavier than on the surface.

This assumption abjectly fails, on examination, to unriddle the problem. What do we find in the outer crust accessible to us everywhere and in the samples of the inner crust sent to us by volcanoes? In the first place the latter is generally quite as highly oxidized as the outer crust. But this is not the main point. At least fifty per cent. both of the outer crust and of the volcanic matters erupted is silica, the specific gravity of the elemental base of which, *silicon*, in its densest crystalline (adamantoid) form is only 2·48. The next most abundant metal, probably 8 or 10 per cent. of the whole, is *aluminum*, whose greatest solid density is 2·807. Next to these in abundance, we have *potassium* and *sodium*, both lighter than water; *magnesium* (heaviest form), 2·14; *calcium*, 2·584; *carbon* (the heaviest, diamond), 3·55; *sulphur* (heaviest), 2·086; and *hydrogen* (liquefied), 0·33. Those already mentioned (with oxygen, which alone constitutes half the weight of the solids of the crust, including the lavas) virtually make up the bulk of the said crust—all the heavier metals together summing up, in all probability, not more than one per cent. Where, then, is the rationality or the justification for the assumption that this nucleus, below the volcanic shell, is made up of heavy metals? The most abundant of these heavy metals, *iron* and *copper*, have the maximum densities respectively of about 8·14 and 8·96 (see SCIENTIFIC AMERICAN SUPPLEMENT, No. 938, pp. 14996–7). As for *lead*—the only common metal that is heavy enough to satisfy the conditions of the problem, being as heavy as 11·5, when compressed—we can scarcely admit so monstrous a supposition as a sphere of lead 6,400 miles in diameter inside our planet. As for *silver*—whose maximum known density is 11·1—it is quite as violent a hypothesis to assume that our globe carries so much of that in its bowels. Were it so, there ought to have been, among the multitude of volcanoes, some one, say like Krakatoa, whose voice is heard a thousand miles or more, obliging enough to throw up for us a million tons or so of it. *Gold*, *platinum*, *ividium*, and other very heavy metals it is scarcely worth while to consider in this connection. They probably never occur among volcanic products. Briefly to sum up; our conclusion must be that in the central parts of the planet earth there is a mystery which, so far as we can yet see, must remain altogether inscrutable to mortal man, whose mission it is nevertheless to "replenish the earth, and *subdue* it." This was the first command ment given to him by his Creator, as found in the first chapter of the first book of Holy Writ.

## THE LUMINIFEROUS ETHER.

SIR G. C. STOKES has recently published some interesting remarks upon a subject about which, he says, the study of light has caused him to think a good deal—namely, the nature and properties of the so-called luminiferous ether. It appeared from his discourse that Sir G. C. Stokes is one of those philosophers who regard the luminiferous ether as a conception of the scientific mind put forward as supplying the obvious need of something for light and gravity to act through or by, thereby avoiding the alternative of supposing these phenomena to be the results of action at a distance. Newton himself scouted the idea of action at a distance as too absurd for any "man who has in philosophical matters a competent faculty of thinking" to entertain. He accepted the existence of an "agent" between bodies affected by gravity; but what this necessary agent might be he was content to leave to the consideration of others. Now, as Sir G. C. Stokes points out, modern science has shifted into the background the difficulty of defining the nature of this unknown agency, by calling it the "ether," which term is in this connection no more than the mathematician's eternal $x$ written in five letters. All that is certainly known about it is negative; while of many aspects from which the conception can be regarded it is impossible to say anything either positive or negative. Granting the physicist his ether, is this the same thing that propagates light and gravity? Sir G. C. Stokes confesses that "we do not know." We cannot conceive of space as other than infinite—is the ether likewise infinite? Again we do not know. Does the ether gravitate toward what we call ponderable matter? This is another question to which no positive scientific answer can be given; and the same remark applies to the question as to whether the ether consists of ultimate molecules, such as those of which there is strong reason for believing that ponderable matter consists. The undulatory theory of light was greatly promoted in the first instance by the known phenomena of sound; but the latter failed to show a counterpart to the phenomena of polarization and double refraction. These phenomena are only intelligible according to the theory of undulations by supposing the vibrations of the ether differ

altogether in character from the vibrations of the air which belong to sound. Hence the ether is not at all like air, and almost the only other thing known about it is that it has not been proved to possess any viscosity, and that the extremely tenuous matter of which the tails of comets is composed does not suffer any noticeable resistance in passing through the space which it is presumed to fill.—*Journal of Gaslighting.*

## THE PROGRESS OF SCIENTIFIC KNOWLEDGE.[1]

By Lord KELVIN.

NOT the least important of the scientific events of the year is the publication, in the original German and in an English translation by Prof. De Jones, of a collection of Hertz's papers describing the researches by which he was led up to the experimental demonstration of magnetic waves. For this work the Rumford medal of the Royal Society was delivered to Prof. Hertz three years ago by my predecessor, Sir George Stokes. To fully appreciate the book now given to the world, we must carry our minds back to the early days of the Royal Society, when Newton's ideas regarding the forces which he saw to be implied in Kepler's laws of the motions of the planets and of the moon were frequent subjects of discussion at its regular meetings, and at perhaps even more important non-official conferences among its Fellows.

In 1684 the senior secretary of the Royal Society, Dr. Halley, went to Cambridge to consult Mr. Newton on the subject of the production of the elliptic motion of the planets by a central force,[2] and on December 10 of that year he announced to the Royal Society that he "had seen Mr. Newton's book, 'De Motu Corporum.'" Some time later, Halley was requested to "remind Mr. Newton of his promise to enter an account of his discoveries in the register of the Society," with the result that the great work "Philosophiæ Naturalis Principia Mathematica" was dedicated to the Royal Society, was actually presented in manuscript, and was communicated at an ordinary meeting of the Society on April 28, 1686, by Dr. Vincent. In acknowledgment, it was ordered that "a letter of thanks be written to Mr. Newton, and that the printing of his book be referred to the consideration of the council; and that in the meantime the book be put into the hands of Mr. Halley, to make a report thereof to the council." On May 19 following, the Society resolved that "Mr. Newton's 'Philosophiæ Naturalis Principia Mathematica' be printed forthwith in quarto, in a fair letter; and that a letter be written to him to signify the Society's resolution, and to desire his opinion as to the volume, cuts, etc." An exceedingly interesting letter was accordingly written to Newton by Halley, dated London, May 22, 1686, which we find printed in full in Weld's "History of the Royal Society" (vol. i., pp. 308–309). But the council knew more than the Royal Society at large of its power to do what it wished to do. Biology was much to the front then, as now, and the publication of Willughby's book, "De Historia Piscium," had exhausted the Society's finances to such an extent that the salaries even of its officers were in arrears. Accordingly, at the council meeting of June 2, it was ordered that "Mr. Newton's book be printed, and that Mr. Halley undertake the business of looking after it, and printing it at his own charge, which he engaged to do."

It seems that at that time the office of treasurer must have been in abeyance; but with such a senior secretary as Dr. Halley there was no need for a treasurer.

Halley, having accepted copies of Willughby's book, which had been offered to him in lieu of payment of arrears of salary[3] due to him, cheerfully undertook the printing of the "Principia" at his own expense, and entered instantly on the duty of editing it with admirable zeal and energy, involving, as it did, expostulations, arguments, and entreaties to Newton not to cut out large parts of the work, which he wished to suppress[4] as being too slight and popular, and as being possibly liable to provoke questions of priority. It was well said by Rigaud, in his "Essay on the first publication of the Principia," that "under the circumstances it is hardly possible to form a sufficient estimate of the immense obligation which the world owes in this respect to Halley, without whose great zeal, able management, unwearied perseverance, scientific attainments, and disinterested generosity the 'Principia' might never have been published."[5] Those who know how much worse than "law's delays" are the troubles, cares and labor involved in bringing through the press a book on any scientific subject at the present day will admire Halley's success in getting the "Principia" published within about a year after the task was committed to him by the Royal Society two hundred years ago.

When Newton's theory of universal gravitation was thus made known to the world, Descartes' *Vortices*, an invention supposed to be a considerable improvement on the older invention of crystal cycles and epi-cycles from which it was evolved, was generally accepted, and seems to have been regarded as quite satisfactory by nearly all the philosophers of the day.

The idea that the sun pulls Jupiter, and Jupiter pulls back against the sun with equal force, and that the sun, earth, moon, and planets all act on one another with mutual attractions, seemed to violate the supposed philosophic principle that matter cannot act where it is not. Descartes' doctrine died hard among the mathematicians and philosophers of continental Europe; and for the first quarter of last century belief in universal gravitation was an insularity of our countrymen.

Voltaire, during a visit which he made to England in 1727, wrote: "A Frenchman who arrives in London finds a great alteration in philosophy as in other things. He left the world full; he finds it empty. At Paris you see the universe composed of vortices of subtile matter; at London we see nothing of the kind. With you it is the pressure of the moon which causes the tides of the sea; in England it is the sea which gravitates toward the moon. . . . You will observe also that the sun, which in France has nothing to do with the business, here comes in for a quarter of it. Among you Cartesians all is done by impulsion; with the Newtonians it is done by an attraction of which we know the cause no better."[1] Indeed, the Newtonian opinions had scarcely any disciples in France until Voltaire asserted their claims on his return from England in 1728. Till then, as he himself says, there were not twenty Newtonians out of England.[2]

In the second quarter of the century sentiment and opinion in France, Germany, Switzerland, and Italy experienced a great change. "The mathematical prize questions proposed by the French Academy naturally brought the two sets of opinions into conflict." A Cartesian memoir of John Bernoulli was the one which gained the prize in 1730. It not infrequently happened that the Academy, as if desirous to show its impartiality, divided the prize between Cartesians and Newtonians. Thus in 1734, the question being the cause of the inclination of the orbits of the planets, the prize was shared between John Bernoulli, whose memoir was founded on the system of vortices, and his son Daniel, who was a Newtonian. The last act of homage of this kind to the Cartesian system was performed in 1740, when the prize on the question of the tides was distributed between Daniel Bernoulli, Euler, Maclaurin, and Cavallieri; the last of whom had tried to amend and patch up the Cartesian hypothesis on this subject.[3]

On February 4, 1744, Daniel Bernoulli wrote as follows to Euler: "Uebrigens glaube ich, dass der Aether sowohi *gravis versus solem*, vis die Luft versus terram sey, und kann Ihnen night bergen, dass ich über diese Puncte ein völliger Newtonianer bin, vnd verwundere ich mich, dass sie den Principiis Cartesianis so lang adhäriren; es möchte wohl einige Passion vielleicht mit unterlaufen. Hat Gott können eine *animam*, deren Natur uns unbegreiflich ist, erchaffen, so hat er auch können eine attractionem universalem materiæ imprimiren, wen gleich solche attractio *supra captum* ist, da hingegen die Principia Cartesiana allzeit *contra captum* etwas involviren."

Here the writer, expressing wonder that Euler had so long adhered to the Cartesian principles, declares himself a thorough-going Newtonian, not merely in respect to gravitation *versus* vortices, but in believing that matter may have been created simply with the law of universal attraction without the aid of any gravific medium or mechanism. But in this he was more Newtonian than Newton himself.

Indeed, Newton was not a Newtonian, according to Daniel Bernoulli's idea of Newtonianism, for in his letter to Bentley of date February 25, 1792,[4] he wrote: "That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it." Thus Newton in giving out his great law did not abandon the idea that matter cannot act where it is not. In respect, however, of merely philosophic thought, we must feel that Daniel Bernoulli was right; we can conceive the sun attracting Jupiter, and Jupiter attracting the sun, without any intermediate medium, if they are ordered to do so. But the question remains, Are they so ordered? Nevertheless, I believe all, or nearly all, his scientific contemporaries agreed with Daniel Bernoulli in answering this question affirmatively. Very soon after the middle of the eighteenth century Father Boscovich[5] gave his brilliant doctrine (if infinitely improbable theory) that elastic rigidity of solids, the elasticity of compressible liquids and gases, the attractions of chemical affinity and cohesion, the forces of electricity and magnetism—in short, all the properties of matter except heat, which he attributed to a sulphurous fermenting essence—are to be explained by mutual attractions and repulsions, varying solely with distances, between mathematical points endowed also, each of them, with inertia. Before the end of the eighteenth century the idea of action-at-a-distance through absolute vacuum had become so firmly established, and Boscovich's theory so unqualifiedly accepted as a reality, that the idea of gravitational force or electric force or magnetic force being propagated through and by a medium seemed as wild to the naturalists and mathematicians of one hundred years ago as action-at-a-distance had seemed to Newton and his contemporaries one hundred years earlier. But a retrogression from the eighteenth century school of science set in early in the nineteenth century.

Faraday, with his curved lines of electric force, and his dielectric efficiency of air and of liquid and solid insulators, resuscitated the idea of a medium through which, and not only through which but *by* which, forces of attraction or repulsion, seemingly acting at a distance, are transmitted. The long struggle of the first half of the eighteenth century was not merely on the question of a medium to serve for gravific mechanism, but on the correctness of the Newtonian law of gravitation as a matter of fact however explained. The corresponding controversy in the nineteenth century was very short, and it soon became obvious that Faraday's idea of the transmission of electric force by a medium not only did not violate Coulomb's law of relation between force and distance, but that, if real, it must give a thorough explanation of that law.[1] Nevertheless, after Faraday's discovery[2] of the different specific inductive capacities of different insulators, twenty years passed before it was generally accepted in continental Europe. But before his death, in 1867, he had succeeded in inspiring the rising generation of the scientific world with something approaching to faith that electric force is transmitted by a medium called ether, of which, as had been believed by the whole scientific world for forty years, light and radiant heat are transverse vibrations. Faraday himself did not rest with this theory for electricity alone. The very last time I saw him at work in the Royal Institution was in an underground cellar, which he had chosen for freedom from disturbance; and he was arranging experiments to test the time of propagation of magnetic force from an induction coil through a distance of many yards to a fine steel needle polished to reflect light; but no result came from those experiments. About the same time, or soon after, certainly not long before the end of his working time, he was engaged (I believe at the shot tower near Waterloo Bridge on the Surrey side) in efforts to discover relations between gravity and magnetism, which led also to no result.

Absolutely nothing has hitherto been done for gravity either by experiment or observation toward deciding between Newton and Bernoulli as to the question of its propagation through a medium, and up to the present time we have no light, even so much as to point a way for investigation, in that direction. But for electricity and magnetisiu, Faraday's anticipations and Clerk Maxwell's splendidly developed theory have been established on the sure basis of experiment by Hertz's work, of which his own most interesting account is this year presented to the world in the German and English volumes to which I have referred. It is interesting to know, as Hertz explains in his introduction, and is very important in respect to the experimental demonstration of magnetic waves to which he was led, that he began his electric researches in a problem happily put before him thirteen years ago by Prof. von Helmholtz, of which the object was to find by experiment some relation between electromagnetic forces and dielectric polarization of insulators, without in the first place any idea of discovering a progressive propagation of those forces through space.

It was by sheer perseverance in philosophical experimenting that Hertz was led to discover a finite velocity of propagation of electromagnetic action, and then to pass on to electromagnetic waves in air and their reflection, and to be able to say, as he says in a short reviewing sentence at the end of his eighth paper: "Certainly it is a fascinating idea that the processes in air which we have been investigating represent to us on a million fold larger scale the saiue processes which go on in the neighborhood of a Fresnel mirror, or between the glass plates used for exhibiting Newton's rings."

Prof. Oliver Lodge has done well in connection with Hertz's work to call attention[3] to old experiments, and ideas taken from them, by Joseph Henry, which came more nearly to an experimental demonstration of electronagnetic waves than anything that had been done previously. Indeed, Henry, after describing experiments showing powerful enough induction due to a single spark from the prime conductor of an electric machine to magnetize steel needles at a distance of thirty feet in a cellar beneath with two floors and ceilings intervening, says that he is "disposed to adopt the hypothesis of an electrical plenum," and concludes with a short reviewing sentence: "It may be further inferred that the diffusion of motion in this case is almost comparable with that of a spark from a flint and steel in the case of light."

Prof. Oliver Lodge himself did admirable work in investigations with reference to lightning rods,[4] coming very near to experimental demonstrations of electromagnetic waves; and he drew important lessons regarding "electrical surgings" in an insulated bar of metal "induced by Maxwell's and Heavisides' electromagnetic waves," and many other corresponding phenomena manifested both in ingenious and excellent experiments devised by himself and in natnral effects of lightning.

Of electrical surgings or waves in a short insulated wire and of interference between ordinary and reflected waves, and positive electricity appearing where negative might have been expected, we hear first, it seems, in Herr von Bezold's "Researches on the Electric Discharge" (1870), which Hertz gives as the third paper of his collection, with interesting and ample recognition of its importance in relation to his own work.

In connection with the practical development of magnetic waves, you will, I am sure, be pleased if I call your attention to two papers by Prof. G. F. Fitzgerald, which I heard myself at the meeting of the British Association at Southport in 1883. One of them is entitled "On a Method of Producing Electromagnetic Disturbances of comparatively Short Wave Lengths." The paper itself is not long, and I shall read it to you in full, from the "Report of the British Association," 1883: "This is by utilizing the alternating currents produced when an accumulator is discharged through a small resistance. It is possible to produce waves of as little as two meters wave length, or even less." This was a brilliant and useful suggestion. Hertz, not knowing of it, used the method; and, making as little as possible of the "accumulator," got waves of as little as 10 cm. wave length in many of his fundamental experiments. The title alone of Fitzgerald's other paper, "On the Energy Lost by Radiation from Alternating Currents," is in itself a valuable lesson in the electro-magnetic theory of light, or the undulatory theory of magnetic disturbance. It is interesting to compare it with the title of Hertz's eleventh paper, "Electric Radiation;" but I cannot refer to this paper without express-

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[1] Abstract from the presidential address before the Royal Society, Nov. 30, 1893.

[2] Whewell's "History of the Indnctive Sciences," vol. ii. p. 77.

[3] It is recorded in the Minutes of Council that thc arrears of salary due to Hooke and Halley were resolved to be paid hy copies of Willughby's work. Halley appears to have assented to this unusual proposition, but Hooke wisely "desired six months' time to consider of the acceptance of such payment."

The pnblication of the "Historia Piscium," in an edition of 500 copies, cost the Society £400. It is worthy of remark, as illustrative of the small sale which scientific books met with in England at this period, that a considerable time after the pnblication of Willughby's work, Halley was ordered by the Council to endeavor to effect a sale of several copies with a hookseller at Amsterdam, as appears in a letter from Halley requesting Boyle, then at Rotterdam, to do all in his power to give publicity to thc book. When the Society resolved on Halley's undertaking to measure a degree of the earth, it was voted that "he be given £50 or fifty 'Books of Fishes.'" (Weld's "History of the Royal Society," vol. i. p. 310.)

[4] "The third [book] I now design to suppress. Philosophy is such an impertinently litigious lady that a man had as good be engaged in lawsuits as nave to do with her. I found it so formerly, and I am now no sooner come near her again hut she gives me warning. The first two books without the third will not so well bear the title of 'Philosophiæ Naturalis Principia Mathematica,' and therefore I have altered it to this, 'De Motu Corporum Libri duo'; but, upon second thonghts, I retain the former title. 'Twill help the sale of the book, which I ought not to diminish now 'tis yours." *Ibid.*, p. 311.)

[5] *Ibid.*, p. 310.

[1] Whewell's "History of the Inductive Sciences," vol. ii. pp. 202-203.

[2] *Ibid.*, vol. ii. p. 201.

[3] *Ibid.*, vol. ii. pp. 198, 199.

[4] "The Correspondence of Richard Bentley, B.D.," vol. i. p. 70.

[5] "Theoria Philosophiæ Naturalis redacta ad unicam legem virium in natura existentium auctore P. Rogerio Josepho Boscovich, Soctetatis Jesu," 1st edition, Vienna, 1758; 2d edition, amended and extended by the author, Venice, 1763.

[1] "Electrostatics and Magnetism," Sir W. Thomson, Arts. I. (1842) and II. (1845), particnlarly § 25 of Art. II.

[2] 1837, "Experimental Researches," 1161–1306.

[3] "Modern Views of Electricity," pp. 369–372.

[4] "Lightning Conductors and Lightning Guards," Oliver J. Lodge, F.R.S. Whittaker & Co.

ing the admiration and delight with which I see the words "rectilinear propagation," "polarization," "reflection," "refraction," appearing in it as subtitles.

During the fifty-six years which have passed since Faraday first offended physical mathematicians with his curved lines of force, many workers and many thinkers have helped to build up the nineteenth century school of *plenum*; one ether for light, heat, electricity, magnetism; and the German and English volumes containing Hertz's electrical papers, given to the world in the last decade of the century, will be a permanent monument of the splendid consummation now realized.

But, splendid as this consummation is, we must not fold our hands and think or say there are no more worlds to conquer for electrical science. We do know something now of magnetic waves. We know that they exist in nature, and that they are in perfect accord with Maxwell's beautiful theory. But this theory teaches us nothing of the actual motions of matter constituting a magnetic wave. Some definite motion of matter perpendicular to the lines of alternating magnetic force in the waves and to the direction of propagation of the action through space, there must be; and it seems almost satisfactory as a hypothesis to suppose that it is chiefly a motion of ether with a comparatively small but not inconsiderable loading by fringes of ponderable molecules carried with it. This makes Maxwell's "electric displacement" simply a to and fro motion of ether across the line of propagation, that is to say, precisely the vibrations in the undulatory theory of light according to Fresnel. But we have as yet absolutely no guidance toward any understanding or imagining of the relation between this simple and definite alternating motion, or any other motion or displacement of the ether, and the earliest known phenomena of electricity and magnetism—the electrification of matter, and the attractions and repulsions of electrified bodies; the permanent magnetism of lodestone or steel, and the attractions and repulsions due to it; and certainly we are quite as far from the clew to explaining by ether or otherwise, the enormously greater forces of attraction and repulsion now so well known after the modern discovery of electromagnetism.

Fifty years ago it became strongly impressed on my mind that the difference of quality between vitreous and resinous electricity, conventionally called positive and negative, essentially ignored as it is in the mathematical theories of electricity and magnetism with which I was then much occupied (and in the whole science of magnetic waves as we have it now), must be studied if we are to learn anything of the nature of electricity and its place among the properties of matter. This distinction, essential and fundamental as it is in frictional electricity, electro-chemistry, thermo-electricity, pyro-electricity of crystals and piezo-electricity of crystals, had been long observed in the old known beautiful appearances of electric glow and brushes and sparks from points and corners on the conductors of ordinary electric machines and in exhaustive receivers of air pumps with electricity passed through them. It was also known probably as many as fifty years ago, in the vast difference of behavior of the positive and negative electrodes of the electric arc lamp. Faraday gave great attention to it[1] in experiments and observations regarding electric sparks, glows, and brushes, and particularly in his "dark discharge" and "dark space" in the neighborhood of the negative electrode in partial vacuum. In [1523] of his twelfth series, he says: "The results connected with the different conditions of positive and negative discharge will have a far greater influence on the philosophy of electrical science than we at present imagine." His "dark discharge" ([1544–1554]) through space around or in front of the negative electrode was a first installment of modern knowledge in that splendid field of experimental research which, fifteen years later, and up to the present time, has been so fruitfully cultivated by many of the able scientific experimenters of all countries.

The Royal Society's Transactions and Proceedings of the last years contain, in the communications of Gassiot,[2] Andrews and Tait,[3] Cromwell Varley,[4] De la Rue and Muller,[5] Spottiswoode,[6] Moultan,[7] Plucker,[8] Crookes,[9] Grove,[10] Robinson,[11] Schuster,[12] J. J. Thomson,[13] and Fleming,[14] almost a complete history of the new province of electrical science which has grown up largely in virtue of the great modern improvements in practical methods for exhausting air from glass vessels, by which we now have "vacuum tubes" and bulbs containing less than 1/190,000 of the air which would be left in them by all that could be done in the way of exhausting (supposed to be down to 1 mm. of mercury) by the best air pump of fifty years ago. A large part of the fresh discoveries in this province have been made by the authors of these communications, and their references to the discoveries of other workers very nearly complete the history of all that has been done in the way of investigating the transmission of electricity through highly rarefied air and gases since the time of Faraday.

Varley's short paper of 1871, which, strange to say, has lain almost or quite unperceived in the Proceedings during the twenty-two years since its publication, contains an admirable first installment of discovery in a new field—the molecular torrent from the "negative pole," the control of its course by a magnet, its pressure against either end of a pivoted vane of mica according as it is directed by a magnet to one end or the other, the shadow produced by its interception by a mica screen. Quite independently of Varley, and not knowing what he had done, Crookes was led to the same primary discovery, not by accident, and not merely by experimental skill and acuteness of observation. He was led to it by carefully designed investigation, starting with an examination of the causes of irregularities which had troubled[1] him in his weighing of thallium; and, going on to trials for improving Cavendish's gravitational measurement, in the course of which he discovered that the seeming attraction by heat is only found in air of greater than 1/1,000[2] of ordinary density; and that there is repulsion increasing to a maximum when the density is decreased from 1/1,000 to 36/1,000,000, and thence diminishing toward zero as the rarefaction is farther extended to density 1/20,000,000. From this discovery Crookes came to his radiometer, first without and then with electrification, powerfully aided by Sir George Stokes.[3] As he went on he brought all his work more and more into touch with the kinetic theory of gases; so much so that when he discovered the molecular torrent he immediately gave it its true explanation—molecules of residual air, or gas, or vapor projected at great velocities[4] by electric repulsion from the negative electrode. This explanation has been repeatedly and strenuously attacked by many other able investigators, but Crookes has defended[5] it, and thoroughly established it by what I believe is irrefragable evidence of experiment. Skillful investigation perseveringly continued brought out more and more of wonderful and valuable results; the non-importance of the position of the positive electrode; the projection of the torrent *perpendicularly* from the surface of the negative electrode; its convergence to a focus and divergence thenceforward when the surface is slightly convex; the slight but perceptible repulsion between two parallel torrents due, according to Crookes, to negative electrification of their constituent molecules; the change of direction of the molecular torrent by a neighboring magnet; the tremendous heating effect of the torrent from a concave electrode when glass, metal, or any ponderable substance is placed in the focus; the phosphorescence produced on a plate coated with sensitive paint by a molecular torrent skirting along it; the brilliant colors—turquoise blue, emerald, orange, ruby red—with which gray colorless objects and clear colorless crystals glow on their struck faces when lying separately or piled up in a heap in the course of a molecular torrent; "electrical evaporation" of negatively electrified liquids and solids;[6] the seemingly red hot glow, but with no heat conducted inward from the surface, of cool, solid silver kept negatively electrified in a vacuum of 1/1,000,000 of an atmosphere, and thereby caused to rapidly evaporate. This last mentioned result is almost more surprising than the phosphorescent glow excited by molecular impacts in bodies not rendered perceptibly phosphorescent by light. Both phenomena will surely be found very telling in respect to the molecular constitution of matter and the origination of thermal radiation, whether visible as light or not. In the whole train of Crookes' investigations on the radiometer, the viscosity of gases at high exhaustions, and the electric phenomena of high vacuums, ether seems to have nothing to do except the humble function of showing to our eyes something of what the atoms and molecules are doing. The same confession of ignorance must be made with reference to the subject dealt with in the important researches of Schuster and J. J. Thomson on the passage of electricity through gases. Even in Thomson's beautiful experiments showing currents produced by circuital electromagnetic induction in complete poleless circuits, the presence of molecules of residual gas or vapor seems to be *the essential*. It seems certainly true that without the molecules there could be no current, and that without the molecules electricity has no meaning. But in obedience to logic I must withdraw one expression I have used. We must not imagine that "presence of molecules is *the* essential." It is certainly *an* essential. Ether also is certainly *an* essential, and certainly has more to do than merely to telegraph to our eyes to tell us of what the molecules and atoms are about. If a first step toward understanding the relations between ether and ponderable matter is to be made, it seems to me that the most hopeful foundation for it is knowledge derived from experiment on electricity in high vacuum; and if, as I believe is true, there is good reason for hoping to see this step made, we owe a debt of gratitude to the able and persevering workers of the last forty years who have given us the knowledge we have; and we may hope for more and more from some of themselves and from others encouraged by the fruitfulness of their labors to persevere in the work.

The president then presented the medals awarded by the society as follows: The Copley medal to Sir George Gabriel Stokes, Bart., F.R.S., for his researches and discoveries in physical science; a Royal medal to Prof. A. Schuster, F.R.S., for his spectroscopic inquiries, and his researches on disruptive discharge through gases and on terrestrial magnetism; a Royal medal to Prof. H. Marshall Ward, F.R.S., for his researches into the life history of fungi and schizomycetes; and the Davy medal to Prof. J. H. Van't Hoff and Dr. J. A. Le Bel, in recognition of their introduction of the theory of asymmetric carbon, and its use in explaining the constitution of optically active carbon compounds.

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THE corner stone of an engineering college for the University of Illinois, to cost $160,000, was laid at Champaign on December 13. Prof. Thurston, of Cornell University, delivered the principal address.

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[1] "Experimental Researches," Series 12 and 13, January and February, 1838.

[2] Roy. Soc. Proc., vol. 10, 1860, pp. 36, 269, 274, 432.

[3] Roy. Soc. Proc., vol. 10, 1860, p. 274; Phil. Trans.

[4] Roy. Soc. Proc., vol. 19, 1871, p. 236.

[5] Roy. Soc. Proc., vol. 23, 1875, p. 356; vol. 26, 1877, p. 519; vol. 27, 1878, p. 374; vol. 29, 1879, p. 281; vol. 35, 1883, p. 292; vol. 36, 1884, pp. 151, 206; Phil. Trans., 1878, pp. 55, 155; 1880, p. 65; 1883, 477.

[6] Roy. Soc. Proc., vol. 23, 1875, pp. 356, 455; vol. 25, 1875, pp. 73, 547; vol. 26, 1877, pp. 90, 323; vol. 27, 1878, p. 60; vol. 29, 1879, p. 21; vol. 30, 1880, p. 302; vol. 32, 1881, pp. 385, 388; vol. 33, 1882, p. 423; Phil. Trans., 1878, pp. 163, 210; 1879, 165; 1880, p. 561.

[7] Roy. Soc. Proc., vol. 29, 1879, p. 21; vol. 30, 1880, p. 302; vol. 32, 1881, pp. 385, 388; vol. 33, 1882, p. 453; Phil. Trans., 1879, p. 165; 1880, p. 561.

[8] Roy. Soc. Proc., vol. 10, 1860, p. 256.

[9] Roy. Soc. Proc., vol. 28, 1879, pp. 347, 477; Phil. Trans., 1879, p. 641; 1880, p. 135; 1881, 387.

[10] Roy. Soc. Proc., vol. 28, 1878, p. 181.

[11] Roy. Soc. Proc., vol. 12, 1862, p. 202.

[12] Roy. Soc. Proc., vol. 37, 1884, pp. 78, 317; vol. 42, 1887, p. 371; vol. 47, 1890, pp. 300, 506.

[13] Roy. Soc. Proc., vol. 42, 1887, p. 343; vol. 49, 1891, p. 84.

[14] Roy. Soc. Proc., vol. 47, 1890, p. 118.

[1] Tribulation, not undisturbed progress, gives life and soul, and leads to success when success can be reached, in the struggle for natural knowledge.

[2] Crookes, "On the Viscosity of Gases at High Exhaustion," § 655, Phil. Trans., February, 1881, p. 403.

[3] Phil. Trans. vol. 172 (1881), pp. 387, 435.

[4] Probably, I believe, not greater in any case than two or three kilometers per second.

[5] Address to the Institute of Telegraphic Engineers, 189.

[6] Roy. Soc. Proc., June 11, 1891.


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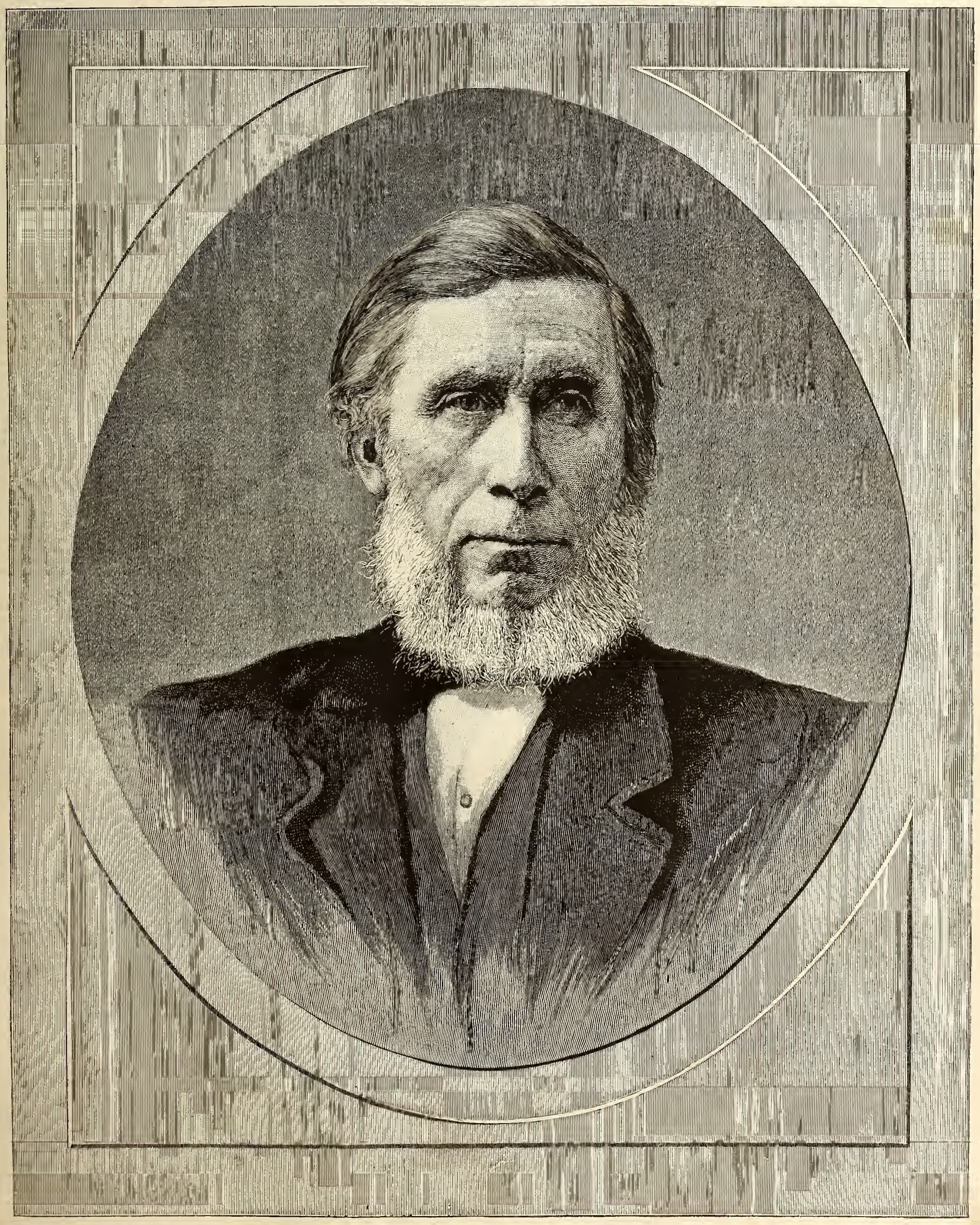


JOHN TYNDALL, F.R.S.

BORN AUGUST 21, 1820. DIED DECEMBER 4, 1893.

*From the Illustrated London News.*

## JOHN TYNDALL.

By JAMES SIME.

EVERY one who takes the slightest interest in the intellectual movements of the present age was sorry to hear of the death of Professor Tyndall. No contemporary man of science was more widely known or held in higher esteem. It cannot, of course, be said that as an original investigator he ranked with the most illustrious discoverers of the nineteenth century. His contributions to knowledge cannot be compared — nor would he himself have wished to compare them—with the far-reaching results achieved by such men as Darwin, Faraday and Joule. Still, even as an investigator, he held an honored place among the scientific workers of his time, and as an expounder of the facts and laws brought to light by physical research, he displayed qualities which have rarely, if ever, been surpassed. In this respect he was equaled only by his friend Professor Huxley.

Tyndall's career, like that of most men of science, was an uneventful one, so far as external incidents were concerned. He was born in 1820, in the village of Leighlin Bridge, County Carlow. The branch of the Tyndall family to which he belonged is said to have sprung from Gloucestershire and to have settled in Ireland in the seventeenth century. His father was a trader in humble circumstances, but was a man of fine intelligence and upright character. He had so high a conception of the value of education that he contrived to keep his son at school until he was nineteen years of age. Tyndall then joined the Ordnance Survey as "Civil Assistant," and in this position, through the kindness of his chief, General George Wynne, R.E., who afterward became his intimate friend, he was allowed to make himself familiar with every department of the survey's work, both in the office and in the field. In 1844 he accepted an appointment offered to him by a Manchester firm, and during the next few years his energies were devoted to engineering in connection with railways. Meanwhile he had become profoundly interested in various branches of abstract science, and his railway work, absorbing as it must often have been, did not prevent him from carrying on studies which accorded with his inclination. In 1847, hoping to obtain more leisure for the development of his scientific powers, he accepted a post at Queenwood College, Hampshire. Here he became intimate with Dr. Frankland, instructor in chemistry; and in 1848 the two friends went together to Marburg, the university of which had been made famous among men of science by the illustrious Bunsen. At Marburg Tyndall worked strenuously, studying not only under Bunsen, but under Stegmann, Gerling and Knoblauch. Afterward he worked for some time with Professor Magnus, at Berlin, so that when he returned to England he had not only a remarkably wide knowledge of physical science, but a thorough mastery of scientific method.

In 1850, during a visit from Germany to England, Tyndall made the personal acquaintance of Faraday, and in February, 1853, he delivered his first Friday evening discourse at the Royal Institution, for which Faraday's labors had secured a splendid reputation. Faraday was so much pleased with the new lecturer that, on his proposal, Tyndall was elected to the institution's chair of natural philosophy, which had been held early in the century by Thomas Young. Tyndall had a warm admiration for the great man who had done him such good service, and his appreciation was finely expressed after Faraday's death in his well-known study of "Faraday as a Discoverer." When Faraday resigned the office of director of the laboratory of the Royal Institution, Tyndall was appointed his successor; and this position he held until 1887, when he retired. In 1876 he married Louisa, Lord Claud Hamilton's eldest daughter, who survives him. They built for themselves a pleasant home at Hind Head; and here, after his retirement, they lived during the greater part of the year, going for the summer months to their chalet on the Bel Alp, overlooking the Aletsch glacier. Professor Tyndall, as all the world knows, had an almost passionate love for the Alps. His first visit to them was paid in 1849. In 1856 he went to them with Professor Huxley, and afterward he allowed no year to pass without breathing their pure, invigorating air. The Alps interested him as a man of science, but their charm lay mainly in the power with which they appealed to his imagination. Tyndall was very far from being one of the Dryasdusts of science. A strong vein of poetry ran through all his thought and aspiration.

His researches on the properties of ice and on their relation to the theory of glaciers occupy an important place in the record of his original work. These researches were carried on partly in his laboratory, partly among the Alps, and have done much to prepare the way for the solution of a complicated set of scientific problems. In 1859 he visited Chamounix, and claimed to have determined by his measurements the winter motion of the Mer de Glace.

Even more valuable were his long-continued investigations on the relation of simple and compound gases and of vapors to radiant heat, especially radiant heat from sources at a moderate temperature. His inquiries on this question form the subject of no fewer than six papers in the "Philosophical Transactions." The conclusions at which he arrived were contested by his friend, the late Professor Magnus; but Sir George Stokes, in referring to them at the banquet given to Professor Tyndall in 1887, said that they had always seemed to him to bear the stamp of truth, and that their validity had been generally admitted. Some of the inferences from Tyndall's doctrine have an important bearing on questions relating to atmospheric temperature and climatological conditions.

For some time much interest was excited in this country by the question of "spontaneous generation." Tyndall threw himself with characteristic enthusiasm into the controversy, and succeeded in proving by a series of carefully planned experiments that the evidence for the theory of "abiogenesis" was wholly inadequate. In this research he had occasion, of course, to use only such methods as were appropriate to his special departments of inquiry, and the result afforded a striking illustration of the value of the services which may, under certain circumstances, be rendered by physics to biology.

Important, however, as these and other investigations were, it is not chiefly to them that Tyndall owes his fame. He ranked among the foremost men of his time, mainly because of his extraordinary power of awakening in the non-scientific public a vivid interest in strictly scientific results and processes. There are not, perhaps, in any language more luminous treatises of their kind than his book on "Heat, a Mode of Motion," his corresponding volume on "Sound" and the essays in his "Fragments of Science." These works are masterpieces, both of thought and style, and it is incredible, even if some of the conclusions set forth in them should become antiquated, that they will ever wholly lose the place they have won in popular scientific literature. They bring out with magnificent power, not only the methods of science, but the grandeur and impressiveness of what may be called its imaginative aspects.

Tyndall, when a boy, found much to interest him in the controversy between Protestantism and Roman Catholicism, and questions relating to religion continued to the last to play a part of immense importance in his intellectual life. No educated person whose memory goes back as far as twenty years can have forgotten the impression produced by the famous address delivered by him as president of the British Association at Belfast. Since that time the public have become so accustomed to the free expression of opinion that it would not be easy for a president of the British Association, even if his doctrines were more "advanced" than those of Professor Tyndall, to create much excitement by a statement of his views. In 1874 the conditions were different, and Tyndall's heresies necessarily gave rise to a prolonged and furious controversy. The address contained no very original ideas, but it was written in a style of remarkable grace and vigor, and at least had the merit of stimulating thought on some of the questions by which the modern world has been most deeply moved. No one would say now—as many said then—that it was the work of a thorough materialist. Some loosely expressed conceptions did seem to point in this direction, but they were not in vital accordance with the general tendencies of Tyndall's thoughts. The intimate friend of Carlyle was not likely to be a man of crudely materialistic principles.

In his later years Professor Tyndall made himself rather prominent by the vehemence with which he fought against home rule. It was natural that he should feel strongly on the subject, but the violence of his language was distasteful to many even of the most resolute opponents of Mr. Gladstone's policy. Probably it was due rather to irritation caused by ill health than to the strength of his convictions. Certainly it had a very misleading effect on those who regarded it as an expression of the essential qualities of his character. Professor Tyndall was at all times apt, perhaps, to give somewhat too dogmatic utterence to his convictions; but in his best days he had a manifest desire to be scrupulously fair in controversy, and it is well known that he often gave evidence of a finely generous temper.—*The Graphic, London.*

## FLAME.*

By Prof. ARTHUR SMITHELLS.

THE subject on which I have the honor to address you this evening is, I am aware, one of the most hackneyed among the topics that have served for popular scientific lectures. I can only hope that it has not quite lost its charm. The chemist is often twitted with having to deal with mere dead soulless things, which at the best only set themselves into angular and unpalpitating crystals. There may be a certain amount of truth in this, but in flames we surely have phenomena of some liveliness. Our flame must be fed; it has its anatomy and varied symmetry; it is vigorous, mobile and fleeting. I do not wish to make extravagant claims, but I do think that one may be excused for feeling almost as much interest in the study of flame as, for example, in the contemplation of the somewhat torpid evolutions of an amœba or the circulation of water in a sponge. To our guileless ancestors, at any rate, flame was a phenomenon of the rarest mystery; unable as they were to discriminate between the material and the immaterial, unable to track the solid or liquid fuel to its gaseous end, this radiant nothingness called flame became to them one of the primary inscrutable, irresolvable things of nature—an all-devouring element, often of peculiarly divine significance.

The essential nature of flame appears to have been discovered at the beginning of the seventeenth century by the Belgian Van Helmont. This remarkable man is well known to chemists as one of the acutest and least superstitious of the whole band of alchemists. He was somewhat speculative in the domain of physiology, but in chemistry Van Helmont made discoveries of fundamental importance. From our immediate point of view, one of the most important things he did was to sweep away the mystery that had so long attached to the gaseous state of matter. In so far as he distinguished between different gases obtained from different sources he may be said to have been the first to bring aeriform matter within the range of substantial things that might be submitted to experimental investigation. It was in consequence of this that he was led to the discovery of the nature of flame. I will quote the important passage from his writings.

"But the flame itself, which is nothing but a kindled smoke, being inclosed in a glass in the very instant perisheth into nothing.

"The flame indeed is the kindled and enlightened smoke of a fat exhalation; be it so; but as the flame is such and true fire it is not another matter, being kindled and not yet kindled, neither doth it differ from itself; but that light being united in its center, hath come upon a fat exhalation which is the same as to be inflamed.

"Let two candles be placed which have first burned awhile, one indeed being lower than the other by a span; but let the other be of a little crooked situation; then let the flame of the lower candle be blown out; whose smoke, as soon as it shall touch the flame of the upper candle, behold the ascending smoke is enlightened, is burnt up into a smoky or sooty gas, and the flame descendeth by the smoke even unto the smoking candle. Surely there is there, the producing of a new being, to wit, of fire, of a flame, or of a connexed light; yet there is not a procreation of some new matter or substance.

"For the fire is a positive artificial death but not a privative one, being more than an accident and less than a substance."

We can best understand the meaning of this somewhat oracular statement by repeating Van Helmont's experiment. We take a bundle of lighted tapers so as to get a large flame, we hold over "in a little crooked situation" another lighted taper, and now blow out the lower flame. We note the ascending column of smoke, and observe that when it touches the upper flame it ignites, and the flame descends several inches through the smoke to the bundle of tapers. Flame, therefore, says Van Helmont, is burning smoke; it is not a new substance nor a mere chance occurrence, but the incandescence of a vapor or smoke that already existed.

Van Helmont only recognized in a vague way the important part played by the atmosphere in the phenomenon. This was realized much more perfectly soon afterward by Hooke, who speaks of "that transient shining body which we call flame" as "nothing but a mixture of air and volatile sulphureous parts of dissoluble or combustible bodies which are acting upon each other while they ascend," an action so violent, he says, that "it imparts such a motion or pulse to the diaphanous parts of the air" as was requisite to produce light.

Without entering further into early historical details, I may say that it was only toward the end of last century that the essential chemistry of the phenomenon was fully expounded by the great Lavoisier. He showed that as Hooke had surmised, flame is the region in which combination attended by the evolution of light takes place between the components of a gaseous substance and the oxygen of the air.

The next step in the history of our knowledge of flame brings us to the memorable researches of Humphry Davy, whose name more than that of any other man is associated with this subject. Of Davy's work I shall have more to say presently; but at this moment I will only make one allusion to it, an allusion which will provide us with a proper starting point this evening. It is interesting to note that Davy's discoveries concerning flame were the consequence and not the cause of the discovery of the miner's safety lamp. In this case practical application preceded purely scientific discovery.

I need not describe the safety lamp to you in Nottingham, where it has recently received such important improvemeuts at the hands of Prof. Clowes. When the lamp is placed in an explosive mixture, you know what happens—the explosive mixture burns with a quiet flame within the lamp, but the flame cannot pass through the wire gauze to ignite the mixture outside the lamp. I can demonstrate this by means of this large gas burner, which is primarily a Bunsen burner, that is a burner which by means of holes at the base of the tubes draws in sufficient air to enable the gas to burn with a practically non-luminous flame. If I turn on the gas and apply a light to the top of the burner, you observe that I get a flash and a small explosion within the tube, but no continuous flame. The fact is that the mixture of gas and air within the tube is highly explosive. Placing a gauze cap over the burner and applying a light, I now get a steady flame. The explosive mixture made in the tube passes through the gauze and is inflamed, or, if you like, exploded; but the explosion cannot pass through the gauze, because the metallic wires withdraw the heat so rapidly that the mixture below it never reaches the temperature of ignition. Above the gauze we have the continuous flame.

"These results are best explained," says Davy, "by considering the nature of the flame of combustible bodies, which in all cases must be considered as the combination of an *explosive mixture* of inflammable gas or vapor and air; for it cannot be regarded as a mere combustion at the surface of contact of the inflammable matter."

Davy, then, regarded flame as being essentially the same as explosion; it was, in fact, a kind of tethered explosion.

Since Davy's time we have learned much about the nature of gaseous explosions, and we now know that such explosions, when fully developed, proceed with enormous rapidity and are of great violence, incapable of arrest by such simple means as we have just used. Still there is not much to correct in what I have said. I think I cannot do better than show you the transition of flame into explosion by an experiment which was first shown by Prof. Dixon in the lecture which he gave at the meeting of the British Association in Manchester in 1887.

The apparatus before you consists simply of a Bunsen burner surmounted by a long glass tube. If I turn the gas on and light it, I obtain at the top of the glass tube a steady flame. The mixture ascending the tube can scarcely be called explosive at present, but if I alter the proportions of gas and air suitably it becomes distinctly explosive. Observe what happens when this is the case. The flame can no longer keep at the top of the glass tube; it passes within it, and descends with uniform velocity till at a certain point it flickers and then shoots down almost instantaneously to the bottom. This sequence of events is exhibited in all cases when flame develops into explosion. We are concerned only with the first phase, viz., that of comparatively slow inflammation, and a flame, we may say, is a gaseous explosion brought to anchor in the period of incubation.

There is one other point connected with explosion that we must note on account of its important bearing on the chemistry of flame. When we are dealing with explosive mixtures of gas and air, we find practically that the composition of the mixture may vary considerably and still retain its explosive properties. There is, of course, a certain mixture which presents the greatest explosive power; a further quantity of the combustible gas or of the air will diminish the explosibility, but not entirely destroy it till a large excess is used. With hydrogen, for example, two and a half times the volume of air (which contains exactly the oxygen requisite to combine with the hydrogen and produce water) is the right quantity for the maximum explosive effect, but we still get explosion when we have much more than two and a half times as much air as hydrogen, or when, on the other hand, we have much less. In one case there will be oxygen left uncombined, in the other case hydrogen. I dwell upon this in order

* An evening discourse to the British Association at the Nottingham meeting, September 15, 1893. From *Nature*.

that we may be prepared to find the same thing in flames, in order that we may not be surprised to find combustion taking place in mixtures where either gas or air is in excess of the quantity actually required for the purpose of chemical combination. Bearing this in mind, let us revert to the experiment that I have just shown. It consists, you remember, in mixing air with gas before burning it, to such an extent that the flame strikes down the tube. On a close examination we find that this is not quite a correct statement, for when I regulate the air with nicety you see that it is only part of the flame that strikes down the tube. There remains all the while at the top of the tube another part of the flame which is not mobile. With a little care I can adjust the proportion of air and gas so that the part of the flame which is mobile shall move up and down the tube like a piston. All the while you see the pale, steady flame at the top of the tube. When in this critical condition a little more air determines descent of the movable part of the flame, a little less sends it to the top.

Let us now turn to the explanation of this phenomenon. It is clear, in the first place, that coal gas and air form an explosive mixture long before there is enough air to burn all the gas. For it is only part of the flame that descends the tube, and there is enough gas passing through this part to form a second flame as soon as it reaches the outside air at the top of the tube. There is, as a matter of fact, only about two-thirds as much air entering the tube at the bottom as would be necessary to burn the whole quantity of gas. We see, in the next place, that the explosibility varies greatly according to the proportions of gas and air. For what is the cause of the descending flame? It is simply that we have an explosive mixture in process of inflammation. The inflammation is tending downward; opposed to it is the movement of the explosive mixture upward. If the upward movement of the unburned mixture is more rapid than the downward tendency of the inflammation, the flame cannot descend. We can only make it descend by making the downward tendency greater. This we do by adding more air, and making the mixture more explosive. We see that we can balance these two opposite velocities with the greatest nicety by a careful adjustment of the proportions of the explosive mixture.

In order to ascertain what proportion of gas is being burned in this movable flame, and what is the chemical character of the products there formed, it is necessary to keep the two parts of the flame separate, and to take out some of the gases from the intervening space.

This is very easily done. The flame descends, we have seen, because its rate of inflammation is greater than the rate of ascent of the combustible mixture. If now we can make this rate of ascent more rapid at one part of the tube than it is anywhere else, we may expect to stop the descent of the flame at that point and keep it there. We can do this simply by choking the passage; for just as a river must flow rapidly where its banks are close, so must the stream of gas rush more rapidly where the tube is choked than either below or above, where there is a wide passage. If, then, I replace the plain glass tube by one that has a constriction in one part, and if I cause the inner cone of the flame to descend as before, it stops, as you see, at the constriction, and will remain there any length of time.

Its rate of descent is greater than the rate of ascent of the gas where the tube is wide, but not so great as that where it is narrowed by the constriction. We have now got the two cones of flame widely separated. In this state of things we can, if we choose, draw off the gases from the space between the two cones by putting in a bent glass tube and aspirating. We could

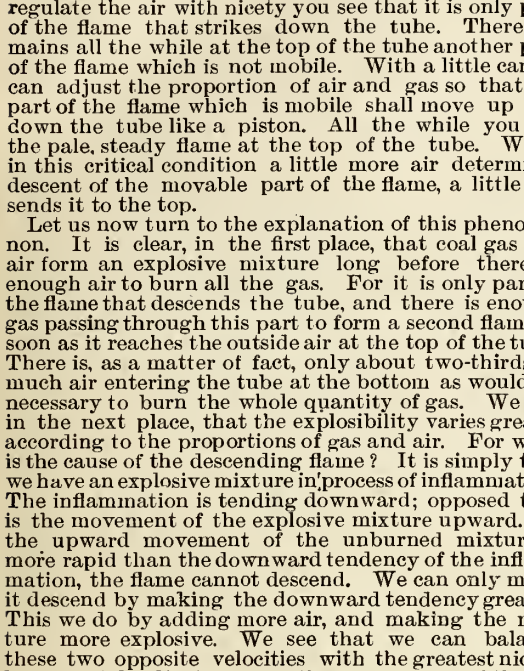



FIG. 1.—METHODS OF SEPARATING THE TWO CONES OF AN AIR COAL-GAS FLAME.

then analyze these gases and see what has happened in the first cone. (Fig. 1, A.)

I will now show you another method in which the two cones can be separated. It is based on the same principles as the one just used. I have here a two-coned flame burning at the top of a glass tube. I shall let the air supply he liberal, but not quite sufficient to cause the descent of the inner cone. The rate of ascent of the gas is now just a trifle greater than the rate of descent of the flame. If now I retard the rate of ascent of the gas, the balance will be disturbed and the inner cone will descend. I can easily do this by laying an obstacle *along* the stream of gas, for at the end of it there will be no more current than you would find over the stern of a boat anchored in midstream. I take this obstacle, then, in the form of a glass rod fixed centrally along the current of gas; I push it up until it touches the tip of the inner cone, and then pull it down again. You observe what has happened. The cone has followed the rod into the tube, and remains attached to it.

You will notice, too, that the cone is inverted. That is easily understood. It is only at the tip of the rod that the current is slowed down; there only is the rate of ascent of the stream less than the rate of inflammation. The tendency in every other part of the stream is for the cone to go to the top; hence the inversion. (Fig. 1, B.)

We can get a still more convenient apparatus by a modification of the first method. Instead of choking the bore of the single tube by a constriction, we may use two tubes of different diameter, one sliding within the other. This apparatus is shown in Fig. 1, C; *a* is the wider tube, *b* the narrower one. The two tubes are connected by an india rubber collar, *c*, and kept steady by the brass guide, *d*. The outer tube can be slid up and down the inner one as desired. If we place this apparatus over a Bunsen burner and turn on the gas, we shall have a tolerably rapid upward current in the inner tube, but as soon as the gas emerges into the wider one, its velocity will of course diminish. The consequence is that if we now light the gas and gradually increase the air supply, the inner cone will descend until it reaches the orifice of the narrower tube; but at that point, meeting with the rapid stream, its progress is arrested, and it remains perched on the end of the tube. By sliding the tubes we can thus separate the cones any desired distance, or we can bring their orifices level and restore the original flame. Lastly, we can restore the original flame. Lastly, we can reverse the experiment, for we can begin with a two-coned flame burning at the protruding end of the narrower tube, and by sliding up the wider tube detach the outer cone and carry it upward. (Fig. 1, D.)

Having now learned the relation of flame to explosion, having discovered that flames have separable regions of combustion, and having armed ourselves with an appliance for dissecting the flame, we may proceed to discuss the main question.

I do not intend this evening to enter seriously into chemical details, hut there are one or two simple points to which I must draw your attention. Flame, we see, is a region in which chemical changes are taking place with the evolution of light. It is to be expected, therefore, that the character of a flame, its structure and appearance, will vary according to the chemical changes that give it birth; and we should naturally anticipate that the more complex the chemical changes, the more complex would be the flame. The kind of complexity to which I refer is illustrated hy the diagram.

| Name. | Composition. | Products. | |
|---|---|---|---|
| | | Partial Combustion. | Complete Combustion. |
| Hydrogen. | | water. | water. |
| Carbon monoxide. | carbon and oxygen. | carbon dioxide. | carbon dioxide. |
| Carbon. | | carbon monoxide. | carbon dioxide. |
| Cyanogen. | carbon and nitrogen. | carbon monoxide and nitrogen. | carbon dioxide and nitrogen. |
| Hydrogen sulphide. | hydrogen and sulphur. | (?) | water and sulphur dioxide. |
| Hydrocarbons. | hydrogen and carbon. | carbon monoxide. carbon dioxide. hydrogen and water. | carbon dioxide and water. |

In the first column are the names of five combustihles; their chemical composition is stated in the second column. All these substances in burning combine with the oxygen of the air. The case of hydrogen is the simplest. This gas, when it burns, unites with half its volume of oxygen, and forms steam. The process is incapable of any complication. We might predict, therefore, a very simple structure for a hydrogen flame. The same is true for the next gas, carbon monoxide, which, although a compound, unites at once with its full supply of oxygen and burns, forming carhon dioxide.

The third combustible, carbon, presents a new feature. In hurning it can combine with oxygen in two stages, forming in the first instance carbon monoxide, which, as we have just seen, can itself combine with more oxygen to form carbon dioxide. We cannot vaporize carbon and use it as a gas; so that we shall not actually deal with this example. But the next combustible on the list, cyanogen, will serve almost as well, for it is a compound of carbon with nitrogen, and nitrogen is, under ordinary circumstances, practically incombustible. To use cyanogen is thus much the same as to use carbon vapor. We may expect some complexity in the cyanogen flame, in consequence of the fact that carbon can burn in two steps. The next combustible, hydrogen sulphide, presents a further degree of complexity. It is composed of two elements, each of which is combustible on its own account. Lastly, we come to the great class of hydrocarbons, which includes all ordinary combustibles, oil, tallow, wax, petroleum, and coal gas. The carbon and hydrogen are both separately combustible elements, and one of them—carbon—is, as we have seen, combustible in two steps.

We will now consider the problem in its simplest aspect. For this purpose I choose the gas carbon monoxide. I should choose hydrogen were it not for the fact that its flame is almost invisible. We will allow a stream of carbon monoxide to issue from the circular orifice of this glass tube. Lighting the gas, we get a blue flame. On examining this flame closely, we perceive that it is simply a hollow, conical sheath of pretty uniform character. I need scarcely demonstrate that it is hollow, but I may do so in a moment by using Prof. Thorpe's simple device of thrusting a match head into the center of the flame—a pin passing through the stick of the match, and its ends resting on the tube. The match head is now thrust well up inside the flame, and you observe that it remains there sufficiently long without burning to make it quite clear that there is no combustion within the cone. The conical form of the flame is easily explained. As the stream of gas issues from the tube the outside portions become mixed with the air and burn. The inner layers must successively travel further upward, like the successive tubes of a telescope, before they can get enough air to burn, and in this way we arrive at the conical form.

There still remains one thing to account for, and that is the luminosity and color of the flame. The questions here involved are perhaps the most interesting of all, but they are complicated, and I will not say more than a few words ahout them. The most obvious answer to the question: "Why is the flame luminous?" is to say that the heat developed during the chemical combination raises the product of combustion to a temperature at which it glows—a "blue heat" in the present case. Now if we put a thermometric instrument into the carbonic oxide flame, it does not register at any point as high a temperature as 1,500° C., but if we take carhon dioxide and heat it in a tube by external heating to 1,500° C., we get no signs of luminosity whatever. On these grounds several eminent investigators have been led to abandon the simple explanation above given, and to say that the luminosity of a carhon monoxide flame must depend not on the heat of chemical combination, but on something in the nature of electrical discharges between the combining substances, which discharges produce the disturbances of the ether

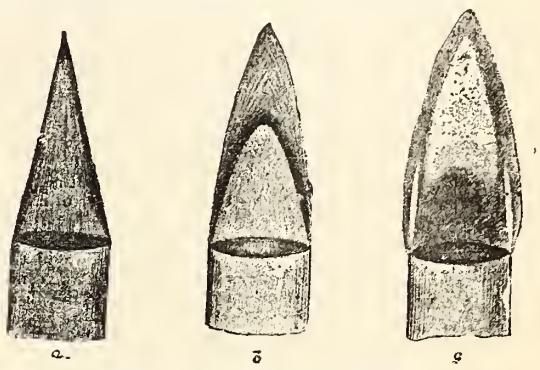



FIG. 2.—TYPICAL FLAMES.

*a*, carhon monoxide, single coned; *b*, cyanogen, two coned; *c*, small coal-gas flame.

perceptible as light. This view seems to be fraught with a fundamental error. The temperature registered by any instrument introduced into a flame is an *average* temperature, uncorrected for losses by conduction. It is not the temperature of the newly-formed gas, but of the mixture of that and the unburned gases. If we had a very small instrument which we could apply to the particles of newly-formed gas, we should undoubtedly find them at a very much higher temperature than any indicated by the ordinary thermometric apparatus, and it is not unlikely that the temperature would be several thousand degrees, approximating indeed to the temperature at which we arrive by calculation from the heat of combustion of the gas and the heat capacity of the product. We cannot say that the flame is luminous from some other cause than simple hotness, for we have no means of seeing whether carbonic acid glows when raised by external heating to a temperature of several thousand degrees.

At the same time one cannot help remarking on the similarity between such a flame as that of carhon monoxide and the appearance presented hy an attenuated gas when submitted to the electrical discharge in a Geissler tube. I have here such a tube, containing carbon dioxide, and I have placed a mask over it, so that we see a long triangular piece of it. When I pass the discharge you see it lights up and presents an appearance strikingly like that of our conical flame of carbon monoxide. There may be a close relationship between the phenomena, but we cannot affirm it yet. No douht we shall soon learn a good deal more about both phenomena.

We have now done with the simplest kind of flame. We see that it consists of a single conical sheath of combustion, at every point of which the same chemical change is taking place, and every point of which in consequence has the same appearance.

We pass to the cyanogen flame. This flame is one of remarkable beauty; it consists, as you see, of two distinct parts: one a rose or peach blossom colored cone, surrounded hy a paler cone, which is bright blue where it is near the inner cone, and shading off to a kind of greenish gray. What is the cause of this double structure? It might be that part of the gas is burning round the orifice, the rest further out in the second cone; but a similarity of the chemical processes in the two parts of the flame is here rendered improbable by the difference in color. The only satisfactory way of answering the question is to separate the cones, and analyze the gases in the intervening space. This we can easily do in the cone-separating apparatus.

I now form the flame at the top of our cone-separating apparatus, and supply a certain amount of air along with the cyanogen. You observe the rose-colored cone contracts somewhat. The gas burning there now gets its air supply easily, and has not to wander outward. If I still further increase the air supply, and make the ascending mixture explosive, you see the inner cone begins to descend into the tube, and passes down until its progress is checked at the narrow tube, where the uprush of gas is more rapid. We have now got the cyanogen flame dissected, and by taking out a sample of the gases from this interconal space and analyzing, we shall find what chemical change has taken place in the inner rose-colored cone. The analysis shows that what takes place is the combustion of the carbon of the cyanogen to form carbon monoxide almost exclusively; the carbon monoxide then ascends, and when it meets with more oxygen in the outer air, burns in a second cone to form carbon dioxide.

Reverting then to the flame of the pure unmixed gas burning at the top of a tube, we see that the gas and air will interpenetrate. When there is just enough oxygen to burn the gas to carbon monoxide, we get the rose-colored cone, and outside it, where this carbon monoxide gets more air, we have a second cone. The two-coned structure corresponds then to two chemical stages of combustion.

Now we might go further and anticipate that if we supplied a very large quantity of air to the cyanogen, as in a blowpipe, the two-coned structure would disappear, for the carbon should be burnt up at once to the ultimate product, carhon dioxide. We can easily try this. I will separate the two cones again in our ap-

paratus, and increase the air supply still further. When I do so you observe that the second cone gradually fades away, and now the whole of the combustion is taking place at the end of the inner tube. Though this is so, the flame is not quite a simple cone. It is, as you see, surrounded by a greenish halo. This halo is due, I believe, as Prof. Dixon has suggested, to the fact that the nitrogen of the cyanogen is not, strictly speaking, incombustible. This has been proved by Mr. Crookes in his beautiful air flame, and besides, the greenish halo is frequently noticeable in cases of combustion where oxides of nitrogen are present.

*(To be continued.)*

## IMPROVEMENT OF POTOMAC FLATS, WASHINGTON.

The improvement of the river front of the city of Washington, D. C., popularly known as the Potomac Flats Improvement, was intended to accomplish two objects: First, to improve navigation, for which annually the government has for years been expending a large sum of money; and second, to fill up a large area of marsh land, which was overgrown with a dense growth of grass. The marshes were what are known as the flats. There were many acres of these marshes bordering on the river bank, which were exposed at low and covered at high tide. One of the largest sewers of the city discharged its contents on these flats, and being exposed daily to the rays of the sun, when the tide was low, rendered a large section of the city almost uninhabitable. The executive mansion itself was only about 2,500 feet from the flats, which became such a public nuisance that what had been one of the most desirable sections of the city became the most undesirable for residence.

In 1881 the Senate appointed a committee to investigate the case. The direct result of this investigation was an appropriation by Congress of $400,000 to begin the work of improvement. Since then successive appropriations have been made at intervals of two years, and the amount expended up to the present time has been $1,624,798. The estimated cost of the entire work was $2,716,365, and notwithstanding the unbusinesslike methods of Congress in appropriating insufficient sums to prosecute the work vigorously, and the damage it has consequently sustained from freshets, the work has been brought to that advanced state that it could yet be completed within the estimates. Considering the magnitude of the work, and the fact that the estimates were regarded as low, this is justly regarded as a satisfactory exhibit.

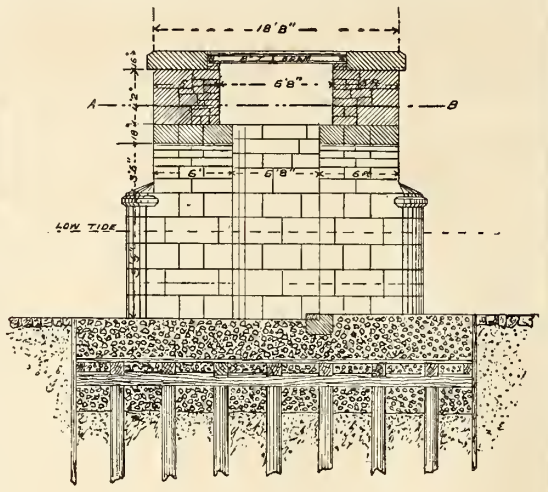
The total area of land reclaimed is in round numbers 621 acres. The material with which the fill was made was taken from the river channels, and thus accomplished the double purpose of improving the navigation and reclamation of the flats.

The question of the disposal of dredgings taken from rivers to improve navigation is becoming a serious one. The old dumping grounds are rapidly becoming filled up, and even when others are found at a long distance from the place to be improved, there is great danger of the material being swept back into some other channel, and thus create a new obstruction where none before existed. In many places satisfactory dumping grounds cannot be found at all; in others the vested rights of adjacent owners of land forbid it.

The work of taking the material from the bed of the river was done in different ways. At first the channels were dredged in the ordinary way, with clam shell and dipper dredges, the material being loaded into scows and then conveyed to a basin located at a convenient point, from which it was again taken up and loaded on railroad cars, which conveyed it to the place of deposit on the flats. The tracks in this case were carried on trestle work, made by driving piles in the flats on the area to be filled, and capping them with heavy timbers. The tracks were raised to a sufficient height to cause the material, when dropped from the cars, to fall with such force that it is spread out laterally to a distance of several hundred feet, and when it did not spread itself, a pump was used to level it down. This method of deposit had several disadvantages. It was expensive. The amount of material that could be dropped at any particular point depended altogether on its character. Soft mud spread out well, but sandy or gravelly stuff did not. The material had to be lifted through a considerable vertical height no less than three times—a wasteful expenditure of energy.

Another method was to dredge the material from the river by means of a centrifugal pump, and force it ashore through pipes carried on scows or pontoons. This work we show in the cut on opposite page, the material being delivered under pressure to a considerable distance. The boat shown in the illustration is 110 feet long; beam of boat, 50 feet. The rotary centrifugal pump is 8 feet in diameter, and 21 inches discharge. Two engines are required to run the pump, each 22 inch cylinder and 24 inch stroke, making 150 revolutions per minute; steam 90 pounds to the inch. Two locomotive boilers, each 60 inch diameter, 25 feet long. Two engines to run the plows, each 10 × 20, running 120 revolutions per minute, discharging through 4,200 feet in length of 20 inch discharge pipe.

This pump has a capacity of 10 cubic yards per minute in stiff blue clay and a greater capacity in other material. Three of these hydraulic dredges were put on the work at various times. The material dredged in this way when deposited on the flats spread itself out in low conical heaps and gave good grades. When the material was very soft, it spread out quite flat. This




RESERVOIR OUTLET—VERTICAL SECTION.

method of dredging proved economical and advantageous, but it was necessary to prepare the place of deposit by constructing embankments around it. As these embankments became in fact a part of the fill and were cheaply constructed, the hydraulic method of dredging was very satisfactory. The centrifugal pump dredge was known as the McNee dredge, and has been used on other important work, giving good satisfaction. As it deepens the channel and deposits the material at any distance required up to one mile at one operation, it is by far the cheapest method that has been employed. Many of these dredges are now in use in different sections of the country. They are owned and operated by the Hydraulic Dredging and Improvement Company, of Philadelphia, Pa.

Another method was introduced at a later stage of the work, and consisted in dredging the material into scows and conveying it to a pump operated on the pulsometer principle. This pump was located near the margin of the flats, and set in a hole in the bed of the river. The dredged material was dumped into this hole, from which it was sucked up by the pump and forced into a chute which carried it out to the place of deposit. The mode of operating the pump was to fill a large cylindrical tank with steam, the pressure from which drove out any material in the tank, and raised it to the top of the chute into which it discharged. By means of a shower bath the steam was then condensed, which closed a valve in the discharge pipe and opened one in the suction. The latter being buried in the dredgings which were deposited over the end of it, and a vacuum being produced by the condensation of the steam in the tank, an inrush of mud or mud and water took place, soon filling the tank. It was then forced out as before. This method of dredging necessitated the construction of long chutes, and as the material had to run down by gravity, the end into which the pump discharged had to be high.

The filling of the flats converted the old Washington channel into an arm of the river, closed at the upper end, into which some sewage would necessarily go. To purify this, a tidal reservoir of about 110 acres was constructed just above Long Bridge, from which about 250,000,000 gallons of water would be discharged daily into the head of the Washington channel.

The water is taken into the reservoir from the Virginia channel on the flood tide and discharged into the Washington channel on the ebb. To control this operation it was necessary to construct, near Long Bridge, the reservoir outlet, which is provided with gates that work automatically, closing on the flood and opening on the ebb tide. A set of inlet gates, to work on the same principle, may also be needed.

The reservoir outlet is a masonry structure, consisting of a breast wall perforated by six arched openings, with two wing walls on the upstream and two on the downstream side. Each opening is 10 feet wide and 13 feet to the crown of the arch, the bottom being 6 feet below mean low tide. The discharge area is therefore 360 square feet at low tide and 540 square feet at ordinary high tide. The gates, when closed, rest against miters at the bottom and top, and when open set back into a recess in the side walls. They are built of wood, and pivoted at the heel, so as to make the friction the least possible. No mechanism is needed to start the gates closing from their positions in the recess of the masonry; the action of the water does this automatically as soon as the tide begins to run up stream.

Considerable difficulty was experienced in securing a foundation for this structure. The bed of the river here consists of very soft mud to a depth of fifty to sixty feet, then layers of sand of varying thickness are encountered, with layers of mud between. At a depth of seventy-two to seventy-five feet a compact layer of gravel is found. As any unequal settlement would disarrange the gates, it was deemed necessary to drive piles to the latter depth. These were capped by two sets of grillage timbers, and the spaces between them, and for two feet below the heads of the piles, were filled in with concrete.

The total amount of material thus far dredged and deposited on the flats is in round numbers about 8,642,000 cubic yards. The price paid for dredging, exclusive of embankments, has varied from 12·37 cents to 21·2 cents per cubic yard, but besides the dredging there has been a large amount of stone used as a footing for the embankments, and foundations for protecting walls. The total cost of the entire work thus far, including everything, has been $1,624,798. The value of the land reclaimed, in its present condition, is estimated at not less than about $3,000,000, so that viewed as a commercial enterprise, it has been a profitable undertaking for the government.

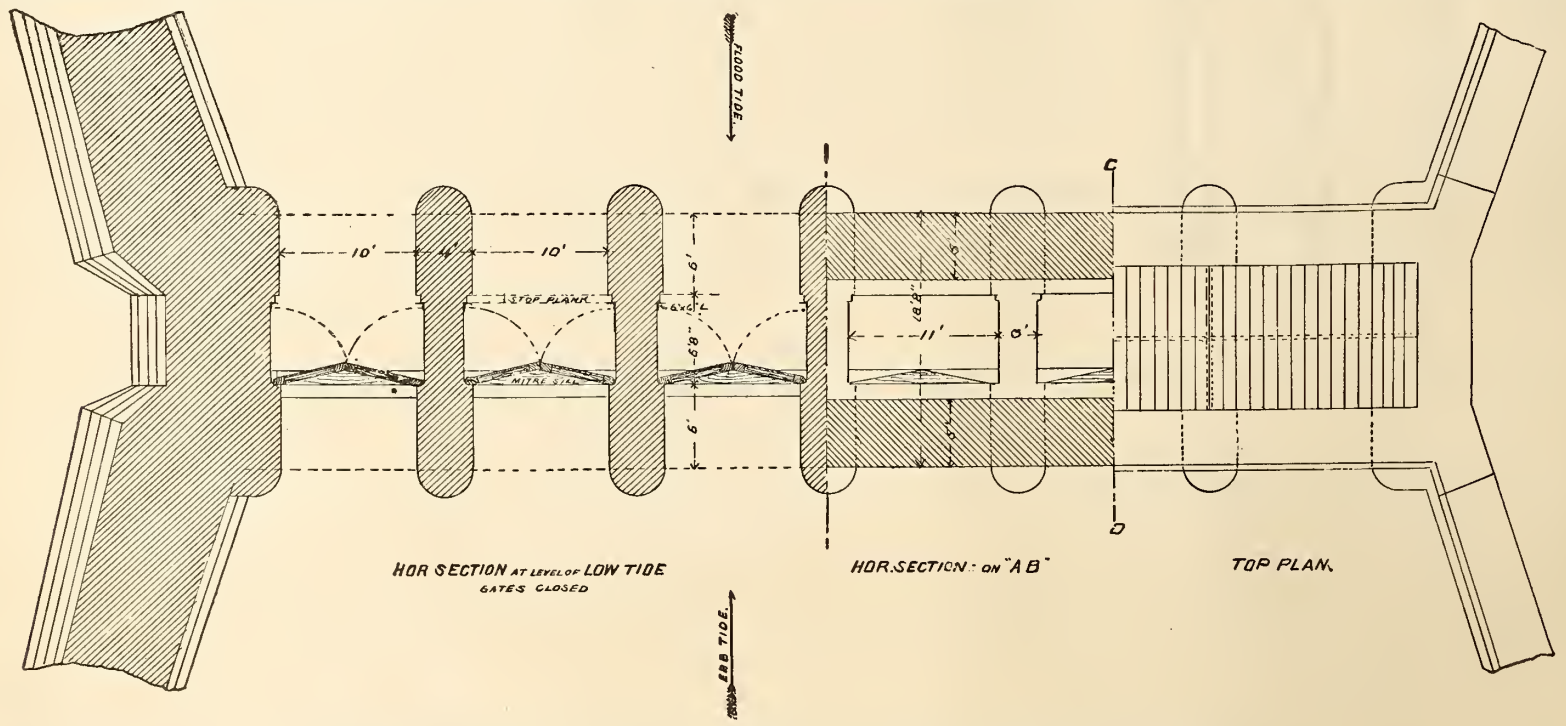
One of the views shows the condition of the flats at low tide, as given by a photograph taken from the top of the unfinished Washington monument in October, 1883, when the monument had reached a height of 384 feet. Another view represents the improvement as it appears to-day, and was taken from the top of the present Washington monument. The diagram, drawn to a scale, gives the relative size and positions of different parts of the work, all of which has been done under the direction of Col. Peter C. Hains, U. S. A., in charge of various public works in the immediate vicinity of Washington, and to whom we are indebted for the details given.

From the Capitol to the Virginia channel is now one large park, marred only by the unsightly tracks of the Baltimore and Potomac Railroad. Embraced in this area are the Botanical Gardens, Medical Museum, Smithsonian, Agricultural Department, Bureau of Engraving and Printing, and the Washington monument. This park is a favorite drive for the thousands of visitors to the capital, and the grounds of the White House border it on the northwest.

## RECLAMATION OF THE POTOMAC FLATS, WASHINGTON, D. C.*

The Potomac River, from Little Falls to its mouth, is a tidal stream, the tidal range at Washington being 3

* Abstract of a paper by Peter C. Hains, Lieutenant-Colonel, Corps of Engineers, U. S. A., M. Am. Soc. C.E.; reprinted from the Bulletin of the Society.



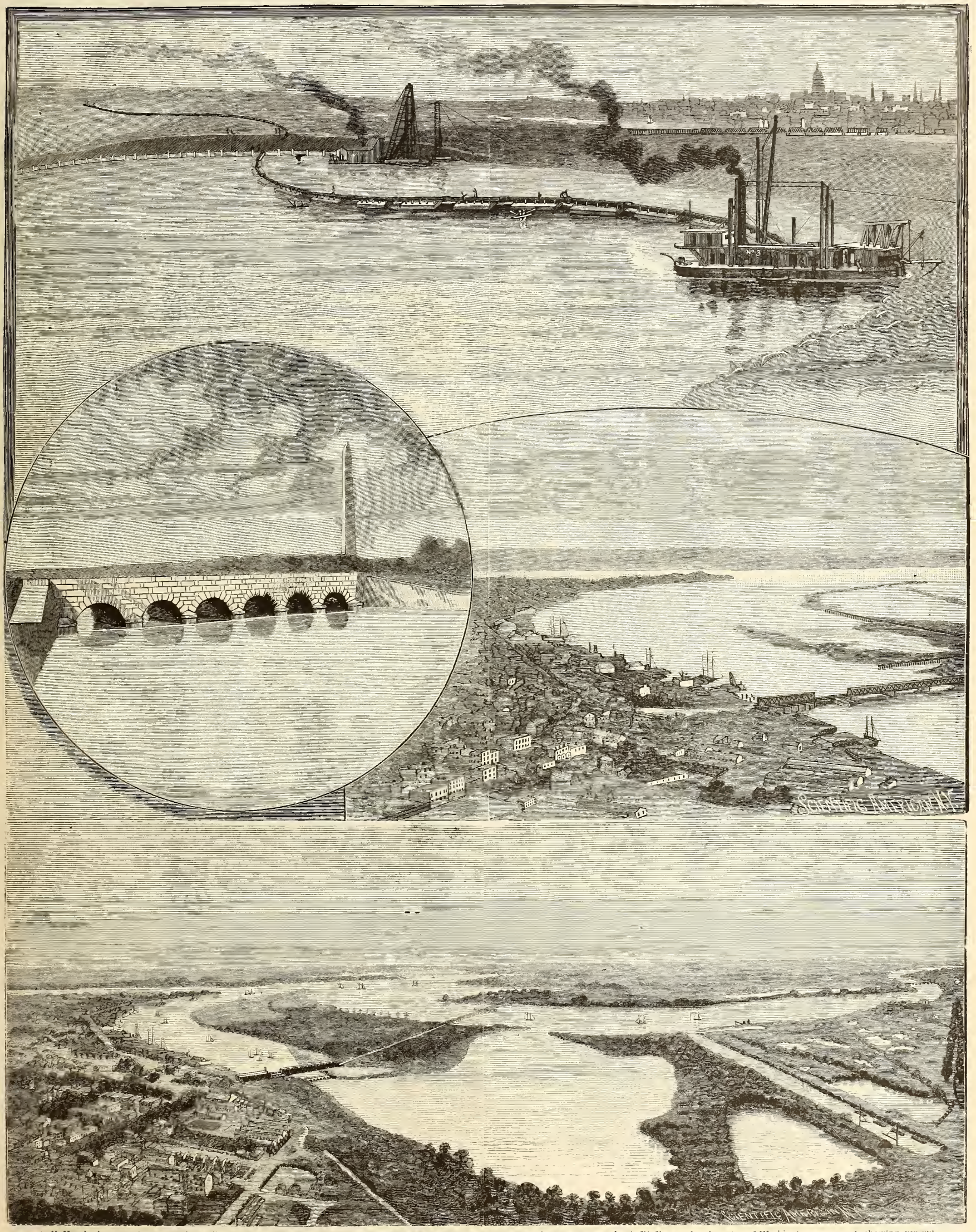

POTOMAC FLATS, WASHINGTON—RESERVOIR OUTLET—HORIZONTAL SECTION.

feet and at its mouth 1½ feet. There is a good channel all the way to Washington, which is rather shoal in a few places and is bordered on the sides with large areas of flats or marshes. From the earliest times there have been always two channels in the harbor of Washington, and sometimes three. The Virginia channel is the widest and deepest, passing between the Virginia shore and Analostan Island. In 1806 this was closed by a dam between the island and the shore and was forced over to the Georgetown side, forming the Georgetown channel. The island thus became a training dike, but was not long enough. The shoal place remained shoal, and a large area of flats was created below the island.

The second or "swash" channel branched off from the Washington channel opposite Sixth Street, pursued a southwest course through the middle of what is now the causeway of Long Bridge, and joined the Virginia channel below Easby's Point. This had a depth of about 6 feet at low tide, but is now almost obliterated. The third or Washington channel branched from the main channel opposite the mouth of the eastern branch, followed along the Washington shore to Easby's Point, and there joined the Virginia channel. This at one time had a depth of nearly 3 feet, but is now almost entirely filled up.

The same causes that produced the shoaling of the channels also formed the Potomac flats at Easby's Point. At their upper limit the river is about 900 feet wide, while immediately below it is about 5,000 to 6,000 feet. This sudden expansion in width causes a deposit of silt in times of freshets, filling the channel to some extent, but filling still more the eddies and dead water behind Easby's Point.

The drainage area of the river is about 20,000 square miles, and freshets reach to a height of 40 to 45




1. McNee dredge removing material to a distance. 2. Reservoir outlet. 3. General appearance of island before the work was commenced. 4. Bird's eye view from top of Washington monument, showing present appearance of island and other reclaimed lands.

## IMPROVEMENT OF THE POTOMAC FLATS, WASHINGTON, D. C.

feet at the falls, discharging the enormous quantity of about 380,000 cubic feet per second. The great quantities of silt brought down by freshets are deposited in the eddies and behind projecting points, and as the water subsides, quantities are deposited in the channels. This filling up requires frequent dredging of the channels, to maintain the requisite depth for commerce. The Potomac flats have continued to increase until they have become a nuisance, which has been aggravated by the discharge of a large amount of sewage upon them, the stench from which is at times almost intolerable. A change in the disposal of the sewage would only lessen but not cure the evil. The question was, Should the flats be filled up above the level of overflow, or dug out so as to form a large area of deep water, or should they be diked in and pumped out? Various plans have been proposed at different times. Mr. Alfred L. Rives submitted plans and estimates for an iron suspension and stone arch bridge across the Potomac to replace the existing Long Bridge; to open the old swash channel, fill out on the Washington side to the edge of it, and turn the waters of the Virginia channel into the new one by means of breakwater, etc.; but the plan was incomplete, and would only have transferred the difficulty to another point of the river.

A plan by the board of survey contemplated filling out on the Washington side along the whole city front to the Virginia channel, the construction of bulkheads and docks, and excavation to 23 feet depth at mean low tide. Over 1,000 acres of land were to be reclaimed.

In 1879 Major Twining, Engineer Commissioner of the District of Columbia, proposed to advance the city front, but not so far. He introduced an entirely new feature—the use of flushing ponds or lakes by which the Washington channel was to be made a tidal arm of the river, closed at the upper end and from all connections with the river. The reservoir thus formed was to be arranged with inlet and outlet gates working automatically with the tides, taking water in at high tide from the Virginia channel and discharging it at the head of the Washington channel on the ebb. The plan reclaimed 528 acres. In 1882 Mr. S. T. Abert, M. Am. Soc. C. E., proposed to fill the flats only to a level of 6 feet above low tide, and protect them from overflow by an embankment. In 1882 a board of engineers, consisting of Lieutenant-Colonels Gillmore, Craighill, and Comstock, of the Corps of Engineers, submitted a plan combining the harbor and shore lines and the low grade filling and surrounding embankment of Mr. Abert's plan, with the high grade filling and sluicing ponds between Long Bridge and Easby's Point of Mr. Twining. The board regarded the rebuilding of Long Bridge, with wider spans, and piers offering less obstruction to the flow of water, as essential. This plan was adopted by Congress and has been nearly carried out. The low grade filling below Long Bridge was modified in 1887 to a fill 3 feet above the freshet line along the axis of this area, sloping off to about 6 feet at low tide, the margin on either side. For the flushing ponds a single lake or reservoir was substituted. The total area of flats reclaimed is about 625 acres, requiring about 12,000,000 cubic yards of material. The law contemplated the taking of the greater part of the material required from the bed of the river.

The first contract made was for dredging the channel to 20 feet depth and 400 feet width. The plan was to dredge the material in the ordinary way and convey it in bottom dumping scows to a receiving basin, where it was to be discharged, and again taken up by a dredge and deposited in cars and hauled to the dumping ground by a locomotive. This necessitated the handling of the material twice, and the construction of a long line of trestle work which soon became useless. The trestle was built on piles mostly 60 to 70 feet long, cut off at about 10 feet above the surface of the flats, and capped with timbers. On these caps longitudinal timbers were laid, and on the latter the rails. The cars were double side dumpers, holding 10 cubic yards each, and were hauled out in trains of 10 cars each, the contents being all dumped at one time. For putting the material on the flats above Long Bridge, 13,000 linear feet of trestle was constructed, and there were deposited on this section about 863,000 cubic yards, giving only about 66 cubic yards per linear foot of track built. To facilitate loading, the tracks at the receiving basin were only 4 feet above low tide, rising by a grade to 12 feet. Below Long Bridge the single line was mostly 12 feet above the flats, and 557,000 cubic yards were dumped from 7,400 feet of trestle; this gave about 75 cubic yards per linear foot. About 120 acres were thus covered by deposits to a depth of about 6 feet above mean low tide. The trestle cost $30,000, or at the rate of two cents per cubic yard of material handled.

After dumping from the cars, the material had to be leveled off by means of a Worthington force pump. By means of this, water was forced through a 4 inch wrought iron pipe with a hose and nozzle attached, but the method was not satisfactory. The material was dredged from an average depth of 18 feet below mean tide, and raised by the first operation 8 feet above tide, or 26 feet in all. It was then towed to the receiving basin, dropped, again picked up and raised 28 feet and loaded into cars. The rise of the grade of the tracks made a still further increase of 6 feet, or a total lift of 60 feet; whereas, the average difference in level between the material in the river and on the flats was only about 21 feet. The price paid was 21·2 cents per cubic yard (scow measurement), which included all the profits to the contractor. At the same time the construction of embankments was begun along the marg'n. These were formed in water 2 to 4 feet deep at low tide. The material was mostly soft alluvium, with some sand. The embankments were made as follows:

An ordinary light draught clam shell dredge would make a cut 6 feet deep at mean low tide, and wide enough to enable her to work conveniently, depositing the spoils on the side toward the proposed fill. Where the water was deep a second cut would be made, widening the trench. Stone was then thrown into the trench forming a ridge 9 feet high, with slopes of 1 on 1. The trench was then further widened and deepened by a dredge with a longer boom, or with a chute carried on a scow.

An endless chain dredge was used after the first cut was made, by which the material was lifted to a height of about 12 feet and dropped into a hopper, from which it was fed to a conveyor and carried to the place of deposit. This conveyor was a line of little cars forming the links of an endless chain, supported on a frame built on scows moored alongside the dredge. By this means the embankments were raised 12 to 15 feet above low tide. Where the chute was used, the material was softened by handling, and, aided by a stream of water, would run 200 or 300 feet beyond the end of it, thus giving a very flat slope to the embankment.

This work extended over a period of seven or eight years, and about 8½ miles of embankment were thus formed. Time had to be allowed where the material was soft for it to harden, and in such cases the work progressed very slowly. The stone in the trench formed a footing for the embankment and a foundation for the dry wall that was afterward constructed. This wall from low water level was 6 feet high, 5 feet wide at the base, 3 feet wide at the top, with the back vertical, and cost $1.70 for the stone and $1.45 for the labor per cubic yard, or a total of about $2.80 per linear foot of wall.

The hydraulic dredges used on the Potomac excavated the material from the bed of the river and deposited it at the desired place on the shore with one operation. The machine consisted of a large rotary pump mounted on a scow, from which a cast iron pipe was led to the bottom of the river. The part leading into the water could be moved about a center from one side to the other, and the end of the pipe thus described the arc of a semicircle about 60 feet diameter. The pipe was made with flexible joints and was carried on pontoons to the shore. The rubber joints were a source of much expense. Under favorable circumstances 30 to 40 per cent. of the volume pumped would be solid matter, but such large quantities did not give good results; as a rule, 10 to 20 per cent. was easily handled, with the engines making 125 revolutions per minute. Working in soft material, one dredge averaged 350 cubic yards per hour for days, the length of the discharge pipe being 3,000 feet, and the height above water level 6 to 12 feet. On one occasion 800 cubic yards per hour were deposited at a height of 10 feet above mean low tide and at a distance of 1,200 feet.

Clay in passing through the pipes would take the shape of balls about 5 inches in diameter, and bowlders as large as a man's head have been forced through. A certain amount of sand and gravel could be handled when mixed with mud or clay, but pure clay could not be handled with advantage, as it cut away the shell of the pumps very rapidly. In sand the discharge pipes were also apt to fill up so as to largely reduce their capacity. On one occasion the sand in the pipes was packed so hard that forcing water through them for two days did not clear them. The water flowing through the discharge pipe at ordinary times had a velocity of about 10 to 15 feet per second.

By this method about 5,000,000 cubic yards of material have been dredged and deposited on the flats at a cost of from 12·37 cents to 15·45 cents per cubic yard. The cost of excavation by the use of the Riker pump was about 13 to 14½ cents per cubic yard.

The total amount of material deposited on the flats up to January 1, 1893, was 9,437,523 cubic yards. Converting place measurement into scow measurement on the basis of 20 per cent. excess, the average price for the whole work done would be 11½ cents, including the profit of the contractor, or a little more than one-half the cost of the same work done by means of scows and railroads on trestles. The filling of marshes in proximity to cities will often pay the cost from the enhanced value of the land created, and is usually desirable from a sanitary point of view, and the hydraulic method is in many places an economical one.

It is found on the Potomac flats that the settlement in material was very small where there was a moderate quantity of sand in it; but where it was pure mud it was considerable and long continued, amounting in three years to 2 or 3 feet, and in seven years more to 1½ feet additional.

The map shows that, according to the plans adopted, the Washington channel would be closed at the upper end and become an arm of the river, in which the tides would rise and fall, but with no tendency to clear itself. With a view, therefore, of clearing it from pollution of sewage, etc., a large reservoir was designed to receive water on the flood tide from the Virginia channel and discharge it into the head of the Washington channel at the ebb. The area of the reservoir, as laid out, was 111 acres, with a depth of 8 feet below mean low tide.

The mean duration of flood tide is about 5½ hours and of ebb about 6¾ hours, and about 14,500,000 cubic feet would be received on the average flood tide, or 29,000,000 cubic feet daily. After careful study it was decided that the inlet gate might be dispensed with, and an open connection made with the Virginia channel. It was hoped the flow of the river would keep the water level at the site of the inlet above that at the outlet, and experience has justified this.

The mud at the outlet has a depth of about 75 feet below tide. The structure for the outlet gate was built upon a pile and grillage foundation, the piles being spaced so as to receive a weight of about 10 tons each. The structure consists of a dam of masonry with six arched openings, connected to the adjacent fill on either side by wing walls. The head walls are built of granite and the wing walls of concrete, the openings are 6 feet wide and 12½ feet high to the crown of the arch. The gates are in pairs, pivoted on vertical axes and swinging, while open, into recesses in the side walls. They butt when closed, like the gates of a canal lock, on miters at the bottom and top, and move easily on the slightest pressure. They close automatically when the tide begins to rise at the head of the channel, shutting off the passage of water into the reservoir, and as soon as the tide begins to fall they open, and allow the water to flow from the reservoir to the Washington channel.

## CRACKED PLATES.

THERE are certain classes of defects in boilers that boiler owners know about and endeavor to avoid. Among these are the deposit of sediment and scale, leakage around tube ends and along riveted joints and overloaded safety valves. These defects rather force themselves on the attention of the owners; but there are many other kinds of defects that are not so obvious, though they may be fully as dangerous. Among these less patent defects are cracked plates.

Fregently cracks start from the edge of the plate, opposite a rivet hole, in the girth joint that comes over the fire. Such cracks are often due to distress at the joint arising from an improper arrangement of the feed pipe; for if the comparatively cold feed water is discharged on or near the fire sheet, it chills the shell in that vicinity, and produces a powerful local contraction of the metal, which is quite sufficient to start the joints, or, under some circumstances, to even crack the solid plate. But whatever the cause of the cracks, they are likely to first appear at the edge of one of the fire sheets and to extend gradually inward. Often they are stopped by running into the rivet hole, and do not extend further. Frequently, however, they run past the rivet hole, or cross it, and extend into the sheet on the further side of it. It then becomes very important to check their further progress. This may often be done by drilling a small hole through the sheet at the very extremity of the crack. This hole may afterward be filled with a rivet, or it may be tapped and filled with a screw plug.

Besides these fire sheet cracks there are numerous other kinds due to different causes. For example, the strength of a plate may be injured by overheating or "burning," so as to develop a serious crack under the ordinary running conditions, without any assignable reason except that it has become too weak to withstand the strain that comes upon it in ordinary usage. Cracks are often discovered, too, along flanges that have been turned to too short a radius. Careless flanging is apt to start small cracks through the skin of the iron, and these frequently extend inward and eventually become dangerous. Incipient cracks on the inside of a boiler sometimes develop into deep grooves, the slight yielding of the shell, under varying pressure, opening the interior of the metal to the corrosive action of the water. Defects of this kind usually occur along the edge of lap joints or near stay bolts, where the shell is partially stiffened and the buckling action of the plates more pronounced.

The accompanying wood cut (Fig. 1) shows a crack

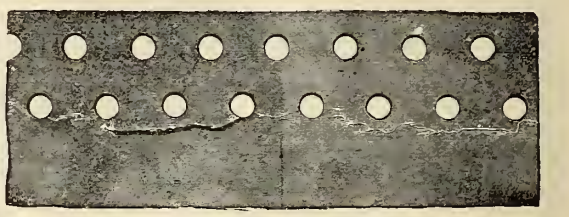


FIG. 1.—CRACKED PLATE.

due to a different cause, and it ought to carry with it a useful lesson. It represents a piece of plate that was cut from a boiler in active service and which was believed to be in good condition. The boiler from which it was taken was 48 inches in diameter, with tubes 15 feet long; and the plates were of steel, ¼ of an inch thick. The piece of plate, shown in the cut, formed the edge of one of the sheets where two sections of the shell were united by a longitudinal, double riveted lap joint. It was taken from the upper part of the boiler, and was not exposed to the fire. It contained one well-marked crack extending completely through the plate, besides many other shorter ones, running into one another in all sorts of ways, some of them extending through the plate and others not quite through it. All these cracks were entirely covered by the inside lap of the joint, so that they could not be seen from the interior of the boiler; and on the outside, the boiler was covered at this point by a thick layer of non-conducting asbestos covering. We mention these points in order that the reader may understand how easy it would be to overlook this defect. Yet it would not be putting the case too strongly to say that, although the boiler appeared to be in good condition, it was actually on the verge of explosion. For a considerable distance along the joint the strength of the plate was entirely destroyed; and at other places it was held together by the merest skin of metal, as was afterward shown by breaking the plate across along the line of the cracks. The fractured area was almost entirely black, though bright spots were noticeable at intervals of two or three inches or so.

The cause of this defect will be sufficiently obvious to those who are familiar with the processes of boiler making. In rolling plates into the cylindrical form, preparatory to riveting them up into shells, it is customary to bend one end of the plate to what is judged to be the proper radius by the use of the sledge ham-

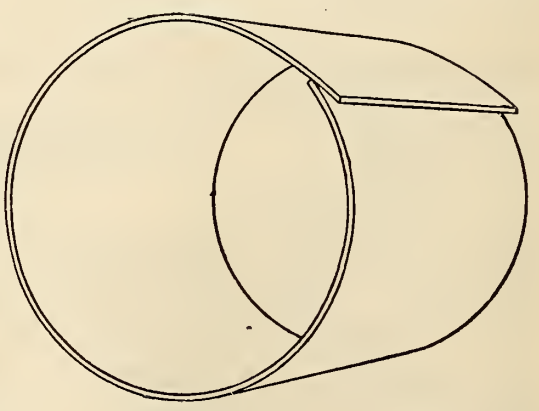


FIG. 2.—ILLUSTRATING THE "OFF-SET" OF THE LAP.

mer. The plate is then run through the rolls and rolled into shape, the end that was previously bent being introduced first. When the plate has been rolled all but the last five or six inches, the last end slips off the first roll, and the rolls can no longer "grip"

the sheet. The result is that the last end of the sheet is not bent to the proper radius, but remains straight or nearly so. The shell (if rolled from one sheet) then looks something like Fig. 2, one end of it "standing off" from the rest of the shell. (This feature has been somewhat exaggerated in the cut in order to show more distinctly what is meant.) In order to bring the outer lap to the proper curvature, it is customary for one man to hold a sledge against the projecting edge of the lap, while another workman strikes the shell on the inside. In this way the lap is bent down into place, and after the shell has been brought to conform with the "sweep" or templet, in every part, it is ready for riveting.

Now it will be seen that the treatment required for bringing the laps together in this manner is rather violent; and it follows that nothing but the best of materials will stand it without being greatly distressed and permanently weakened. Under the sledging operation the material is likely to be strained beyond its elastic limit, unless it possesses great ductility. The greatest strain on it comes on the outer lap, at or near the line where it touches the inner one in Fig. 2. We have no doubt that the cracks shown in Fig. 1 were started in this way, and that they afterward crept into the plate gradually, as the boiler yielded slightly under varying pressures until they reached the highly dangerous state described above.

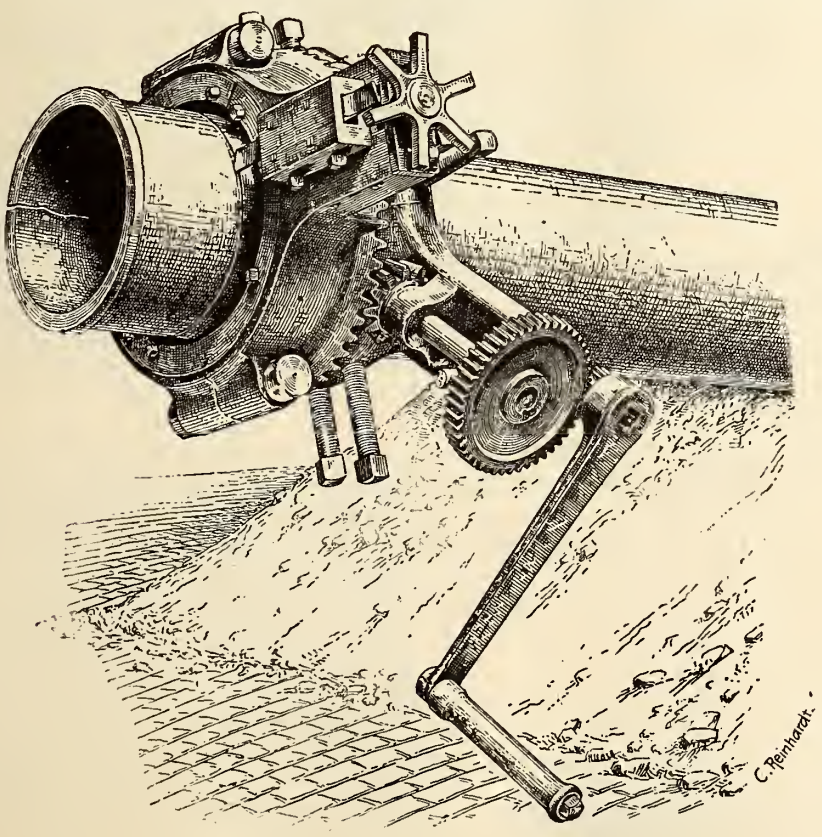
If the sledging were done while the sheet is hot, it would not be so objectionable; but the great majority of boiler makers will not attempt to heat the plate before sledging the lap down, because when the sheets are hot they are apt to buckle out of shape and give great trouble.

In the early days of steel boilers, before the manufacture of that material was understood as well as now, plates were much more apt to be injured by sledging than they are at present. Steel having a high tensile strength is almost certain to be deficient in ductility; and for this reason it is customary, in the specifications sent out from this office, to make the maximum allowable strength of plate 65,000 pounds to the square inch, when such plate is to be exposed to the fire. We also specify that the steel used shall show an elongation of twenty-five per cent. in a length of eight inches, that it shall show a reduction of area of not less than 56 per cent., and that its elastic limit shall be at least 50 per cent. of its ultimate strength. The plate should also be capable of being bent double and hammered, when either hot or cold, without showing cracks; and it is also desirable that it should stand this same test after being heated and quenched in water. Steel that possesses these qualities makes excellent boilers, and it will stand a great deal of abuse, in the boiler shop, without developing defects in after service.

In conclusion, we may say that cracked plates are not so uncommon as the average reader might suppose. This may be seen by glancing at our inspectors' reports, as published from month to month in the *Locomotive*. Thus we find that during the year 1892 our inspectors discovered no less than 2,646 plates that were cracked in one way or another, of which 658 were considered to be dangerous.—*The Locomotive.*

## IMPROVED PIPE-CUTTING MACHINE.

THE machine, by Geo. W. Dudley & Company, St. Louis, Mo., may be explained as follows: The crank motion operates a shaft actuating a bevel gear which in turn operates a toothed wheel revolving on a fixed wheel, with even bearing on all portions of its frictional surface. The revolving wheel carries the tool post; the cutting tool is worked automatically on each revolution by a cam projecting on the fixed frame supporting the crank shaft.




IMPROVED PIPE-CUTTING MACHINE.

The width of the cutting tool is about $\frac{5}{64}$ of an inch, properly proportioned to the frictional strain of cutting. The manner of adjusting the machine is simple—by set screws, and is easily adjusted, as the first revolution of the machine will determine the accuracy of setting. The machine can cut to a bevel by adjusting the set screws. It can also cut a dovetail on the edge of the pipe for the purpose of shrinking a wrought iron bead on the edge of the pipe. By changing the cutting tool and substituting a round nose gouge tool, beads may be cut near the edge of the pipe to correspond with like beads in a bell joint if required.

Repairs on large water mains, insertions of branches and gates, are in most cases attended with great risks by the time taken to do it and the fear of fire breaking out in the district while the water is shut off. The liability of disturbing weak sections of a pipe in making repairs on broken sections are observed and experienced in the necessity for breaking out by use of sledge, sections of broken pipe. The cutting and trimming of a fractured pipe frequently results in cracking other parts of the pipe. Damage to the eyesight of workmen by cutting, chipping, and breaking off iron into small fragments frequently occurs.

By the use of this machine the time taken out of the service for distribution, in making repairs and alterations, is reduced fully two-thirds, it is claimed, compared with old methods, and that other difficulties disappear.—*Master Steam Fitter.*

## VELODROMES OR PERMANENT TRACKS FOR BICYCLISTS.

OF all modern sports, cycling is certainly the one that has most quickly taken root among us. From the beginning, it gave rise nearly everywhere to races, which, despite their necessarily defective organization, have not a little contributed toward diffusing this sport. Now that Queen Bicycle has the freedom of the city with us and that powerful associations have been formed on all sides and notably in the great centers, the need has been felt of the creation of velodromes, that is to say, of closed fields in which racers and amateurs can devote themselves at their ease to their favorite exercise. Independently of the security that is obtained by a track essentially tight, that is to say, closed on every side, they can find here medical attention within their reach, and at the same time a private room in which they can rest at their ease and change costume. The English, much in advance of us, have had such tracks for a long time.

In France, it was Bordeaux that gave the example. As long ago as 1885, the Velo-Club, of that city, constructed the Saint Augustin track, which was 375 meters in circumference. A few years later the tracks of Jarnac and Pau appeared simultaneously, and finally that of Courbevoie, at Paris. This latter, copied after the English tracks, was provided with elevated curves that allowed the racers to pass over them without danger and without slackening their speed.

Since 1890, we have seen appear in France the tracks of Buffalo at Paris, of the Velodrome of the Park at Bordeaux (Fig. 1), of Lille, of Reims, and finally the

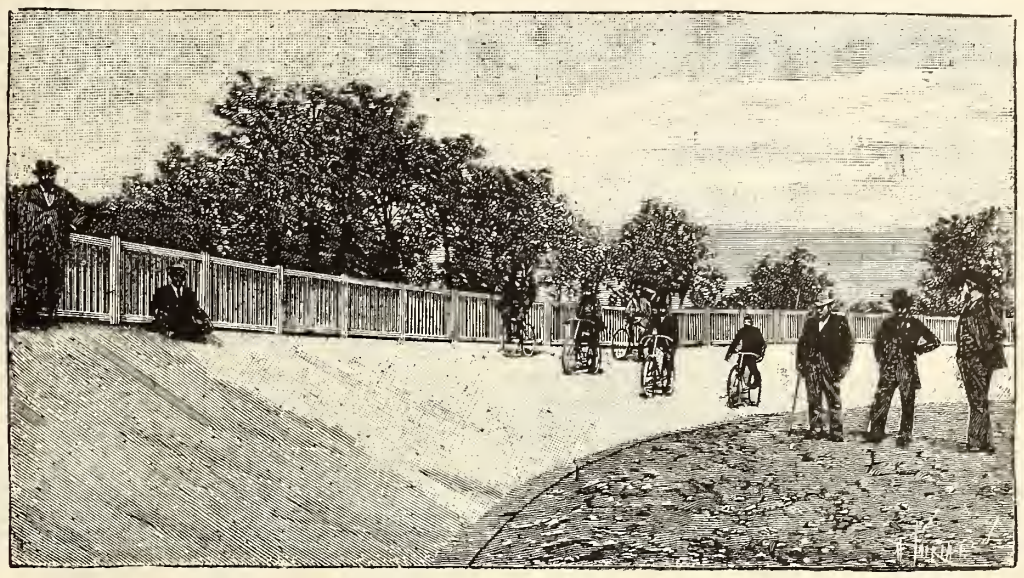


FIG. 1.—BICYCLE TRACK OF THE PARK VELODROME, AT BORDEAUX—AN ELEVATED CURVE.

track of the Velodrome of the Seine, at Paris, which seems to be a model of its kind.

Cyclists, by reason of the ease with which their machine is steered, have no need of a track presenting a great circumference, and, contrary to what happens in horse races, bicycle races gain by being run in a circumscribed space, because the spectators much more easily follow all the phases of the contest.

Now, a circuit that varies from 333 to 500 meters necessarily has elevated curves of quite feeble radius. To pass over them, the racer, rushing forward at a speed that to-day reaches 50 kilometers an hour, is obliged to lean inwardly in order to combat centrifugal force. In this position, the wheels of his machine would swing if the ground were horizontal. It is for this reason that one has been led to form curves sloping from the exterior to the interior and the inclination of which should be so much the greater in proportion as the radius is smaller and the speed greater. This is what is called the rise of the curve. If such rise be well calculated, when the racer passes at the greatest speed his machine should have its vertical longitudinal plane perpendicular to the earth of the track.

Exact calculations would be quite difficult to establish in order to reach a normal rise, for there enters into the calculation an essentially variable element—the weight of the racer. It is preferable to adhere to the results of experience, and we have established on this subject an empirical formula $\frac{15}{2R}$, which, up to the present, has given very good results.

Generally, in order to establish these elevated curves, the ground is leveled as much as possible, and then earth is brought and formed into a shelving ridge, of which Fig. 2 gives a sectional view. The form of the

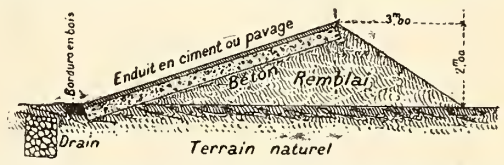



FIG 2.—ELEVATED CURVE OF EARTHWORK.

track has been previously decided upon. According to the ground at one's disposal, two straight lines connected by two arcs of a circle, whose radius should not fall below 25 meters, are provided for (this is the classic form), or else a track is made having an elliptical form, and which is composed only of arcs of circle connected with each other.

We have here, moreover, two systems, in presence of which each has its partisans, and the respective merits of which we do not care to discuss. Let us merely say that both have their advantages and disadvantages.

On the subject of the rise, of which we have just spoken, we should mention the pronounced subsi-

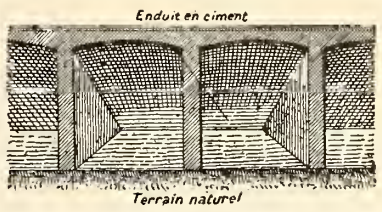



FIG. 3.—VAULTED ELEVATED CURVE.

dences that take place in the earthwork of the elevated curves, and that habitually occur every time an embankment is established. On another hand, rain, in the long run, wears away the back slope of 2 meters in 3. seen to the right of Fig. 2.

In order to obviate this, there has been inaugurated at the Park track, at Bordeaux, a system of elevated curves constructed upon vaults (Fig. 3). These vaults are entirely of beton, and, along with the vertical

walls, are moulded on the spot. The space between each wall is 2 meters; the thickness is 0·10 meter, and all the directions are concentric. These curveways are more costly than those made of carted earth, but they assure a greater stability on the surface of the track, which, in the other case, experiences risings and settlings, due solely to the slow and irregular subsidence of the filling.

In England, the superstratum of the first tracks was composed of ashes and pounded bricks, forming a layer of 0·10 meter that rested upon a foundation of very solid coarse materials. This was already very good, but numerous improvements have since been introduced into the track.

At present, the model track of Herne Hill, at London, is formed of a wooden floor. The objection has been made to this sort of track that it possesses a certain flexion; but, despite this, the speeds do not seem to feel the effects of it, and the Herne Hill track is considered the best in England.

In France the majority of the tracks are formed of a stratum of beton from 15 to 20 centimeters in thickness, covered with a smooth coat of cement mortar 0·01 meter in thickness. This was the method of construction of the track of the machinery gallery at the Champ de Mars, Paris. Such tracks afford high speed, but, when they are not under shelter, the elevated curves become slippery when they are wet by rain.

A new system has just been inaugurated at the Velodrome of the Seine, in employing a wooden pavement analogous to that of streets, except as to the thickness, which does not need to be so great, seeing that with the rolling of cycles it can be anticipated that the wear will be null. This mode of construction is very costly, but the track will last indefinitely without repairs, and, upon the whole, in the long run, a saving will be able to be effected by this fact.

A track, in order to be safe, should be completely inclosed externally.

In the interior, on the contrary, there should be no inclosure, for at a critical moment a racer must be able to betake himself to the greensward.

The velodrome, in order to be complete, should be provided with a sprinkling apparatus and a restaurant, or at least a refreshment room. There already exist a dozen velodromes in France, and many others are projected or are in the course of construction. This is a consequence of the favor that cycling enjoys at present.

From the standpoint of physical exercise, we should rejoice at this, for, of all sports, cycling is the one that develops the most organs at once. Medicine, for a moment rebellious, has entirely changed its first manner of looking at it, and the heads of the profession do not hesitate to preach by example.—*La Nature.*

## A BICYCLE TOURNAMENT.

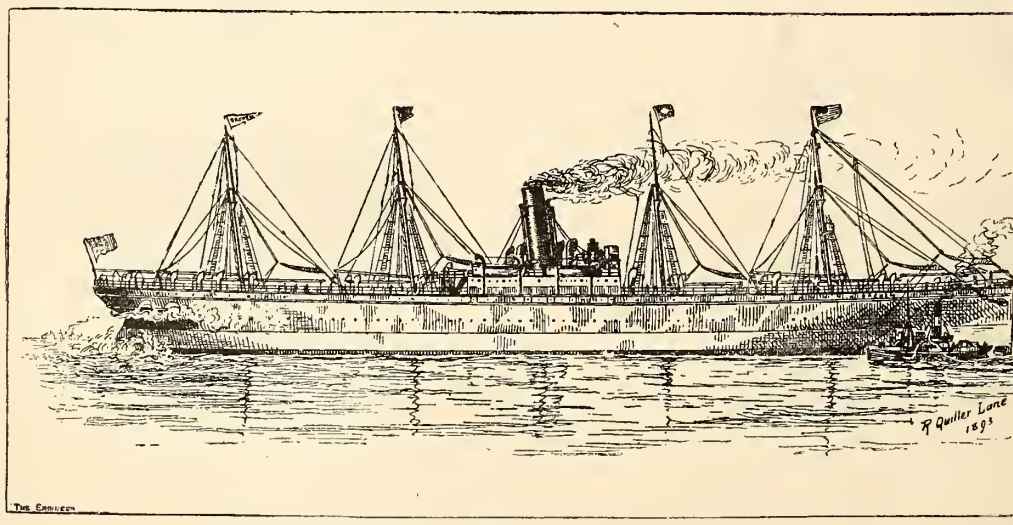
THE greatest six-day bicycle race ever held in the world was brought to a close Saturday, Dec. 30, at ten o'clock in the evening in the presence of thousands of spectators. The race was held in Madison Square Garden, New York City, the great length of this building offering an excellent track for bicycling. The race was a very successful one from almost all standpoints. Every record has been broken by Schock, the new champion, who won easily, breaking the record with twenty-four hours to spare. Waller, the German, who came in second, showed remarkable speed and endurance, but he was lacking in ambition and courage, and it was with difficulty that he was kept on the track by his friends and trainers. Martin (the champion of 1891) came in third, and did remarkably well, considering his bad physical condition, as he was attacked by a serious stomach trouble the second day of the race. The expenses at the Garden were very heavy, so that the winners were disappointed in not receiving a share of the net receipts. The official score at the close of the race was as follows.

| | Miles. | Laps. |
|---|---|---|
| Schock | 1,600 | 3 |
| Waller | 1,484 | 8 |
| Martin | 1,430 | 1 |
| Albert | 1,410 | 1 |
| Van Emburg | 1,401 | 1 |
| Golden | 1,313 | 1 |
| Meixell | 1,190 | 0 |
| Forster | 1,045 | 0 |
| Barton | 1,006 | 3 |
| Ashinger | 879 | 2 |

## STEAMER FOR THE MANCHESTER SHIP CANAL.

WE publish a sketch of a very large and fine steam vessel which has been lately built to run between Manchester, England, and New Orleans. By the opening of the new ship canal between the river Mersey and Manchester, the latter city has lately become a seaport. Our engraving is from *The Engineer.*

It represents the steamship Sachem exactly as she appeared steaming away from the Abercorn Basin, where she has just been finished by Messrs. Harland & Wolff. She has been built for Messrs. George Warren & Co., Liverpool, and has a gross tonnage of about 5,230. She is intended for the cattle trade, two decks being fitted up for their proper and safe conveyance. She has a double bottom for water ballast, and deep tanks adapted for either water ballast or cargo. The Sachem has four masts—of a peculiar form—steam winches, steam windlass, and all the latest appliances for the rapid and efficient handling of cargo, and will be lighted throughout by a complete installation of electric light plant. She is driven by a single screw and powerful triple-expansion engines, supplied by her builders. In reference to her masts, it will be noted they are very short and stumpy, and only provided with topmasts for the sake of appearance. These would, of course, be struck on entering the canal to permit of her passing under bridges.




THE MANCHESTER SHIP CANAL STEAMER SACHEM.

## AMERICAN, EGYPTIAN, AND INDIAN COTTON BALING.

THROUGH the kindness and courtesy of the largest spinning concern in Chemnitz I can give the department definite and very desirable information, backed up by photographs.

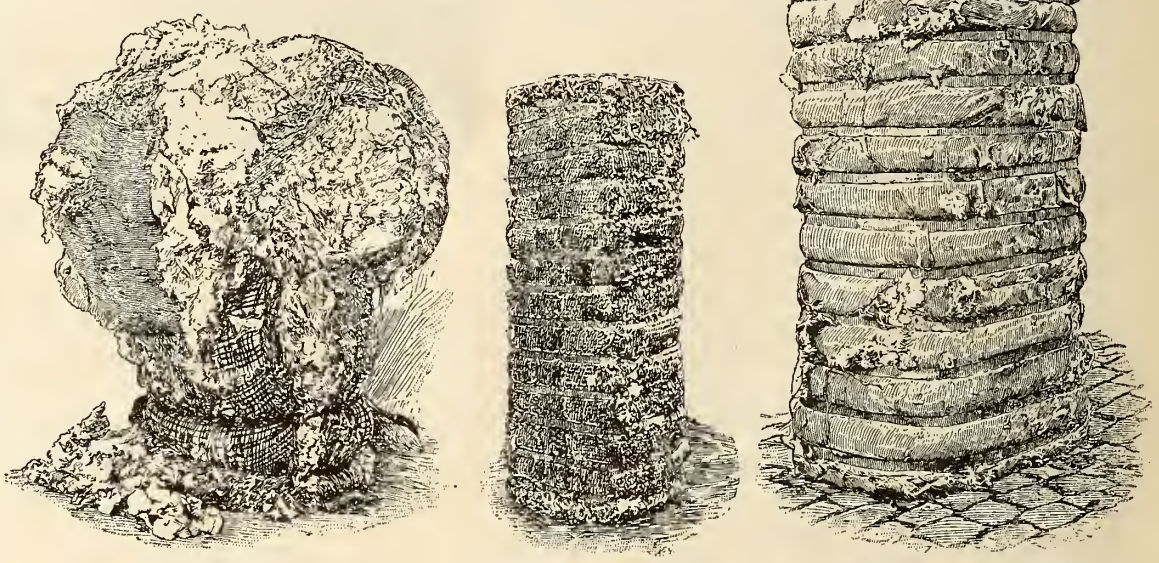
The packing of American raw cotton causes a deal of anxiety and complaint here. The jute cloth covering is so torn before the bales reach Chemnitz that the cotton is exposed to mud, water, fire, and theft. Of the original six or eight iron bands, two, three, four, and sometimes more are loose or broken; the cotton bulges out, takes up dirt and dust when in a dry place, mud in the docks, sea water when in the ships, and rain water when on land, on wharves, or in transmission by boat, rail, or wagon. In transport every gust of wind tears away pieces of the valuable commodity. The wharves, custom house floors, and freight cars are usually covered with pieces torn or dropped from such bales; and the danger from fire is great, for cotton ignites easily, and sparks from cigars or locomotives, fanned by winds, even those caused by the movement of a train or wagon, could cause not only the burning of the cotton, but of other valuable property.

Contrasted with the packing of Egyptian and Indian cotton, the American must be regarded as very bad. Both Egyptian and Indian have close, compact, tough coverings, are rather long and smooth, leave little or none of the cotton exposed, are easily and plainly marked, and are wrapped close and bound strong and tight. Along the sides the firm's or seller's name appears. On both ends the kind of cotton is indicated to aid in identification, should one end be torn off in handling, as sometimes happens. Thus, in the case of Indian and Egyptian cotton, mixing of bales with and without marks seldom if ever occurs; on the other hand, with American cotton both happen very frequently—too frequently, hence the complaint.

The Indian and Egyptian bales are so tightly pressed, so well covered and bound, that injury from fire, water, dirt, dust, etc., is minimized. Take this table as to space occupied by the different bales:

| Bales of Cotton. | Weight. | Space occupied. |
|---|---|---|
| | Pounds. | Cubic feet. |
| Egyptian | 70 | 15 |
| Indian | 400 | 10 |
| American | 475 | 22 |

The Lloyd's, who can pack into their vessels' holds 16,000 to 18,000 bales of Indian cotton, can take only 6,000 to 10,000 American, when, according to the ratio of weights (4 to 4¾), they should take in 14,000 bales. Consider this in the figuring of expenses, where $3, $4, $5, etc., are paid per cubic yard for ocean freights. What appears here in the matter of ships holds equally good in relation to transport wagons, room taken up in freight houses, magazines, and storehouses, etc., all of which add to the expenses. I am informed that producers, as well as manufacturers, have to pay "enormous sums" for these "unnecessary" expenses. Besides, the American planters waste large quantities of unnecessary packing material. The losses by dirt, dust, mud, bursting of the bales, by stealing, etc.,



AMERICAN BALE, 500 POUNDS. INDIAN BALE, 400 POUNDS. EGYPTIAN BALE, 700 POUNDS.

COTTON BALING.

affect the producer and manufacturer in about the same ratio.

The increased danger of fire increases the premiums on fire insurance policies. The mixing of the bales and the "no mark bales" cause no end of confusion. More secure packing, a much closer pressing, and greater care in covering or wrapping up, would be of inestimable and permanent benefit to the cotton trade of the United States.

Planters formerly entertained a fear that the enormous pressure used in India would injure the fine fibers of the American cotton, would make more difficult the processes of cleaning, and would cause the formation of small knots which would injure the carding machinery, but such belief has disappeared. The fact that Egyptian cotton, with as fine or finer and longer fiber, has stood greater pressure satisfies everybody interested that the time has come for a reform in American methods of packing. Of course, great care is to be taken before packing to see that the cotton is perfectly dry; otherwise, internal fermentation will create "cakes," resulting in the same danger to the carding machinery as that caused by the little knots described above. Egypt and India have small fear of these dangers, because of their particularly dry climate, especially during the packing and shipping season.

The photographs of these bales of cotton as they reached the spinning mill at Chemnitz tell their own story more graphically than words can tell it.

J. C. MONAGHAN, Consul.

Chemnitz, October 14, 1893.

## HOW WINDOW SHADES ARE MADE.

THE illustrations of this subject were taken from the manufactory of the Caleographic Window Shade Co., Jersey City, N. J. The standard shade at the present time is the sun proof holland. The first operation in their manufacture takes place in what is called the long cloth room. Fastened to the beams above, about 25 ft. apart, are tracks containing a number of trolley wheels suspended from which are short pieces of heavy wire linked together. Pieces of timber, placed end to end, running the length of the room, are hooked by means of screw eyes to the ends of the wires. Strips of the best grade of muslin, 175 ft. in length and ranging from 3 to 10 ft. in width, are tacked and pasted on the top and bottom edges to these pieces of timber. They are then drawn taut by means of pulleys connected to the floor and bottom pieces of timber. The muslin is then sized over with glue and water. When dry the painting operation begins. Instead of the old method of putting it on with the brush, it is now put on with muslin stretched over wooden blocks, which causes the paint to be rubbed thoroughly into the muslin. This requires the labor of three men to a strip. The first man puts the paint on roughly; the next man smooths and levels it, and the third man rubs it in and finishes it. The strips are painted in different tints. The ingredients are a mixture of zinc, oil and white lead. The room is heated for drying purposes to a temperature of 70°. After drying the strips are removed and taken to the trimming machine. The painted muslin is first rolled around a circular iron rod and placed in one end of

the machine. The strip passes over and under eight steel rolls, about 1½ in. in diameter, during the operation of trimming.

The second, fourth and seventh rolls are raised by means of the lever at the side of machine, when the attendant places the end of strip in position for trimming. As soon as the strip is in place the lever is pushed back and the rolls are drawn back in their sockets. The pressing down of the rolls keeps the strip smooth and in place as it passes under the trimmers. There are two trimmers on each side of the machine, one over the other. They can be moved back and forth on the roll or shaft and gauged to cut different widths of shades by means of a screw. The trimmers are made of steel and are about 3 in. in diameter, with a ¼ in. flange at one end. The outside edge of the flange of the lower trimmer just grazes the inside edge of the upper trimmer. This causes the strip to be cut as it passes through.

The material is taken up by another roll at the end of the machine. It is then taken to the cutter and hem marker. The hem marker is made of two bars of steel about 2 in. in width, 4 ft. in length, 1½ in. apart and grooved on the under side. These bars are connected at each end to a circular rod 1½ in. in diameter. Directly underneath the grooved bars is a steel plate, the sides of which are raised, like the shape of a triangle. The rods pass through the center of this plate and down to a foot lever below. The attendant then passes enough cloth for a shade underneath and between the rods. The lever is then pressed down, forcing the grooved bars down over the raised surface of the plate, which makes an impression for the hem. A knife is then passed along the side of bars separating the shade from the roll. The shades are then taken to the printing press. The designs are printed from etched plates. The rolling beds of the presses are made of iron and are hollow. They are 4 ft. in length, 3 ft. in width and 4 in. in thickness. The etched plate is placed on the center of this bed and a hand roller coated with paint is run over it. The end of shade to be printed is carefully placed over the plate, with a heavy strip of paper on top. Over this is placed a thin sheet of steel. The bed, which rolls on wheels attached to the sides of press, is pushed forward under a sheepskin scraper. The lever is then drawn forward, which forces the scraper down on the steel plate. The press is then set in motion by an attendant turning the crank. This draws the bed containing the plate through the press. The pressure of the scraper on the steel sheet causes the impression to be made on the shade. The bed is then drawn back, the printed shade taken off and another placed over the plate to go through the same operation. The printed shade is then coated with pulverized wool called flock. Dados are printed from blocks. They are 1 foot square and about 3 in. in thickness. The design is made of small strips of sheet brass projecting out about ¼ in. from the surface. To print, the face of the block is first placed in what is called a paint float. This is a box-shaped contrivance, about 2½ ft. square and 3 ft. in height, containing an 8-in. zinc-lined reservoir filled with water, resting on the surface of which is a shallow box with a canvas bottom. The block is placed face down on the canvas bottom, which is covered with a thin coating of paint. By pressing the block against the canvas every part of the design is at once covered with paint. The operation of printing is then begun by pressing the block on one corner of the shade, printing about 1 foot at a time, and repeating the operation until the dado is finished. After the shades can be handled they are taken to the hemming room, where they are finished and made ready for shipping. The printing presses will turn out about 100 pairs of shades per day each.

## THE WASTE OF ANTHRACITE.

By HENRY WURTZ, Ph.D.

IT may be stated, at the outset of this article, that some of the more important facts conveyed therein are derived from an address of Eckley B. Coxe, Esq., as president of the American Society of Mechanical Engineers. Mr. Coxe is stated to be the largest individual coal miner and producer in the anthracite regions—employing much the largest number of men—and has passed his whole career, rising to position and distinction, in this pursuit. His complete familiarity with the subject, in all its aspects and prospects, past, present and future, is undeniable; and his reliability admits of no doubt. To this it may be added that he has from the first been a member of the Pennsylvania State Commission, appointed some years ago to investigate this great problem of the apparently lavish and wanton waste of one of Mother Earth's greatest treasures, the "solidified sunshine" that she has buried in her bosom for us, her offspring.

The above remarks are here thrown out, in view of the great mass of confused, conflicting, biased and often erroneous opinions that have been entertained relative to this subject, in its various bearings and connections. It will be well to regard such positive statements as we find made by Mr. Coxe as entitled to all confidence.

Some of us may remember the early days when all the anthracite was delivered to the retail trade, and often even to private consumers, in the *lump* form just as mined, and had to be broken up by hand tools. Then came up gradually the great machines called coal breakers, in which it is now crushed with magic rapidity by the most ponderous machinery, then picked over by hand or by other machinery, screened, sorted and gradated mechanically, at present into at least nine different sizes, each of which has, or rather should have, its special functions to fulfill. In the case of the smaller sizes, the character of the functions of these appears yet to involve mooted points, and to be still a matter of investigation and of controversy. In such investigation Mr. Coxe has taken an active part.

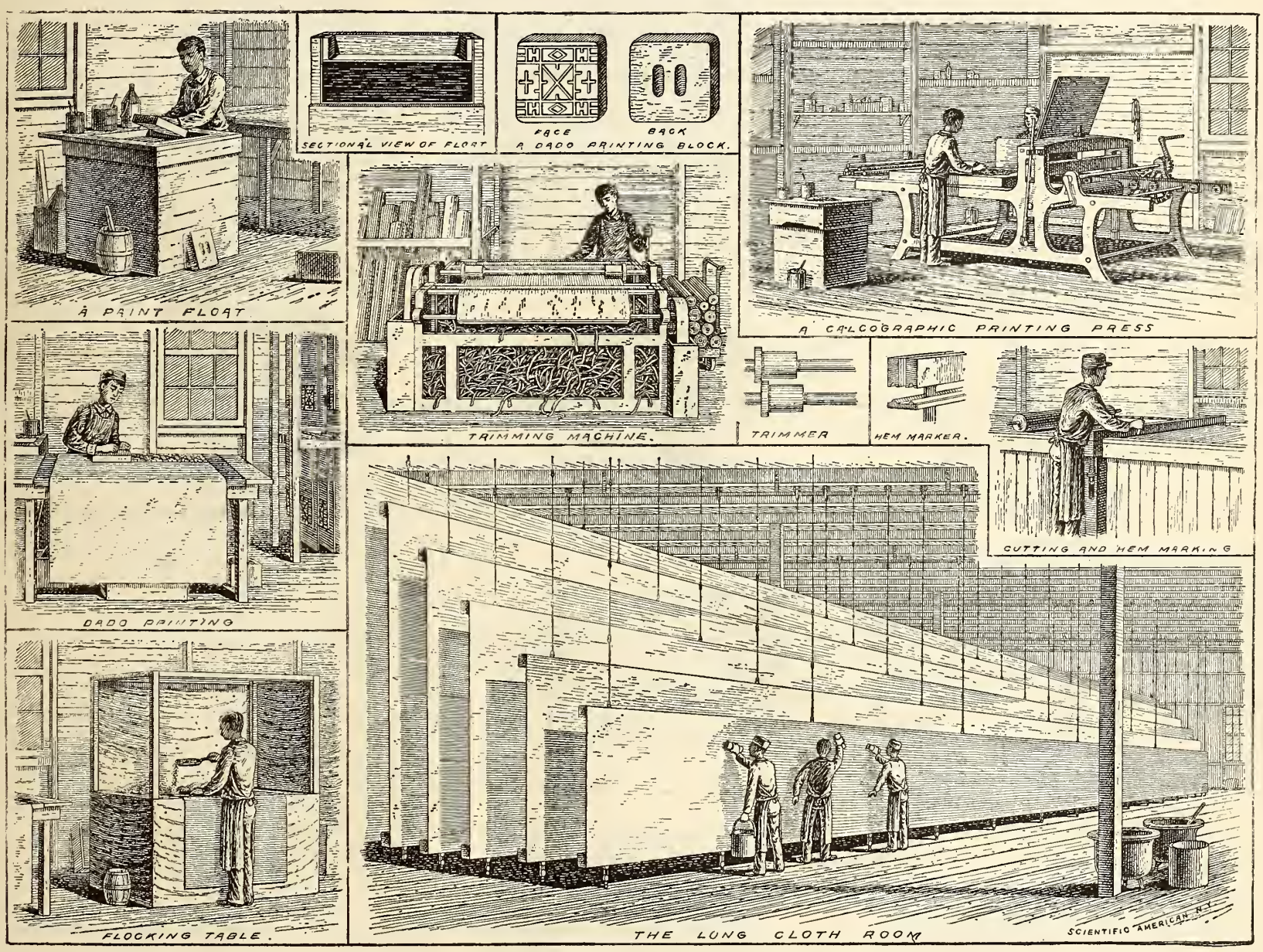
The names now usually attached to the nine different sorts of screened and sized anthracite now offered in the market are as follows, beginning with the largest size: 1, lump; 2, broken; 3, egg; 4, stove; 5, chestnut, or simply nut; 6, pea; 7, buckwheat; 8, rice; 9, barley.

The names of Nos. 8 and 9 are novel to the writer, being of rather recent origin, and applied to what have been sometimes called Buckwheat No. 2 and Buckwheat No. 3. Mr. Coxe, to convey ideas regarding the average sizes of the smaller of these sorts, which are not so familiar to most consumers as the larger sizes, tabulates them as follows, with the dimensions of the (round punched) screen meshes used in sorting them; adding further the prices at the mine:

| | Made through. Inch. | Made over. Inch. | Approximate price at mines. |
|---|---|---|---|
| Chestnut..... | 1½ | ⅞ | $2.75 |
| Pea..... | ⅞ | 9 16 | 1.25 |
| Buckwheat ..... | 9-16 | ⅜ | 75 |
| Rice..... | ⅜ | 3-16 | 25 |
| Barley..... | 3-16 | 3-32 | 10 |

He states also that the cost of transportation of the small sizes is less than that of the large; 30 cents per ton less than domestic sizes, for pea size to tidewater, and 50 cents less for rice and barley sizes.

As was to be expected, obstacles have been encountered in the attempts to make markets for the smaller sizes, called rice and barley coal. The grates in use for the larger sizes of course could not burn these to advantage, and consumers naturally objected to putting in new grates, and remodeling their fireboxes




## MANUFACTURE OF WINDOW SHADES.

*Second and Third.*—These depend reciprocally on each other, being low percentage of carbon and high percentage of ash. He has found that with the small, as with the larger sizes, the amount of steam made per ton of coal depends on the amount of carbon, not on the size; but for equal heating surface the amount of steam made in equal time decreases with the size of the coal. Mr. Coxe himself burns as much as 150,000 tons per year of the small sizes for making steam, and finds it a matter of much personal advantage to exercise care and skill in its preparation, and insure by chemical determinations, carried on continually, of the amounts of carbon and ash, as well as of the specific gravity, keeping the smaller sizes up to the mark. The amount of ash increases curiously with the diminution in size, contrary to what was formerly the popular opinion. This fact was observed in 1886, by Mr. Ashburner (formerly of the Pennsylvania Geo-

logical Survey, now deceased). Ashburner found for different sizes from the same breaker taken at the same time: For the ash in egg, 5·662; in stove, 10·174; in chestnut, 12·666; in pea, 14·664; in buckwheat, 16·62.

Coxe obtained for ash the following figures:

| | Per cent. |
|---|---|
| In lump coal | 5·00 |
| In broken coal | 7·52 |
| In egg coal | 8·50 |
| In stove coal | 8·39 |
| In chestnut coal | 9·50 |
| In pea coal | 11·45 |
| In buckwheat coal | 9·87 |
| In rice coal | 13·85 |
| In barley coal | 13·05 |

Special precautions are required in the sampling, or great errors may result in these ash estimations. The writer gathers from Mr. Coxe's remarks on this head that the reasons for these results must lie in the modes of occurrence of much of the mineral impurity in anthracites. Pyrites and some other minerals often occur in thin cross seams in the coal; being, through their thinness, fragile, and cleaving off easily from the larger fragments, thus concentrating in the smaller sizes. It would seem that thin slaty and possibly "bony" seams must often partake of this same easier detachability. Before Ashburner obtained his results in 1886, the general opinion was that the smaller coal was liable to be freer from ashy impurity than the larger. Now, however, that Ashburner's figures are so entirely confirmed by Coxe, we must regard the principle as established that the smaller the size the more ashy. This throws something of a damper on the prospect of utilizing the immense culm heaps throughout the anthracite country. Nevertheless ways may yet be found. Difficulties, in order to be overcome, must first be completely and correctly comprehended.

The report of the Pennsylvania State Commission on anthracite waste, published last June, says that the amount of anthracite that had been mined up to that time was in all 902,000,000 tons—estimating that 315,700,000 tons in all have been sent to the culm banks. Much of the latter amount has been lost through being washed away and set on fire and by being made into railroad embankments, etc. Still, very likely 100,000,000 tons may remain, much, however, in a rather impure condition. It can be partially purified; and operations have been carried on at several points, such as Rondout, N. Y., and Mahanoy City, Pa., to make it into briquettes, or "eggettes," so called, with pitch, but the pitch has been found too costly and uncertain in supply. It has been burned successfully to some extent in admixture with bituminous culm—an ancient plan; and it has been shown that such a mixture may be caked with success, and forms a good fuel. The writer suggests a trial, for caking it, of wood pulp gelatinized by zinc bichloride.

## IMPROVED SMOKE ANNIHILATOR.

WE illustrate Elliott's smoke and fumes annihilator, which, *Engineering* says, has been at work at the Birmingham Mint for several months, and to inspect which a number of engineers from London and the provinces lately visited Birmingham. The principle of the invention, which was experimentally tried in London two years ago, is to wash the smoke thoroughly and to utilize the carbon precipitated in the water as well as the fluid drained off.

Fig. 1 shows the general arrangement of the installation. The stack, which is 100 ft. high from the ground level and 6 ft. 6 in. in diameter, takes the smoke from three Lancashire boilers, one 30 ft. by 8 ft., and two 28 ft. by 7 ft. 6 in., each with two flues, and a three-flue boiler 22 ft. by 6 ft. In addition there is discharged into the stack the smoke from six large mufflers for hot rolling and annealing.

Formerly the Birmingham Mint was occasionally fined for allowing dense smoke to be emitted from the stack, and this, in large measure, induced the directorate to try Elliott's invention after seeing it at work at his establishment at Newbury, Berks. The fumes, instead of being allowed to pass up the chimney, are drawn off by fans at a height of about 12 ft. from the ground. Fitted into the shaft or stack is a cone with the large end downward, reducing the diameter at top to 3 ft. 6 in. An 18 in. pipe pierces the shaft, but it is proposed to substitute a 30 in. pipe, for reasons which we shall indicate later. This pipe, shown in Fig. 1, is connected to the induction opening of a fan, the casing of which is shown on the front elevation and half longitudinal section (Fig. 2), as well as on the plan (Fig. 3). This is a four-vane fan with ordinary flat surfaces, and has been found to work more satisfactorily than many other arrangements. The diameter is 3 ft. 6 in., and it is driven by belting as shown; it runs at a speed of about 1,600 revolutions per minute.

As the function of this fan is to arrest the progress of the smoke up the chimney and drive it into the washing chamber, or annihilator, as it is called, it is necessary that it should work efficiently; otherwise smoke will find its way up the chimney, and, although the stack might under certain conditions be dispensed with, there would still be necessary a sufficient induction draught to insure combustion in the boiler. It is desirable that the air pressure given by the fan should be 10 in. according to the water gauge, but at the speed given it is from 8 in. to 9 in. It is proposed, however, instead of driving the fan from a separate engine, to convey the motive power from the hot rolling mill engines through a shaft underground for 50 ft. This shaft will run at 100 revolutions per minute. It is hoped by this means to increase the speed of the fan, which, combined with a larger pipe already referred to, will give greater efficiency. The fan it may be stated is cleansed from sooty deposits by jets of water which play upon it and the bearings.

The smoke is forced through a pipe into a revolving barrel fitted with long blades as shown in the end section (Fig. 4). This revolving barrel, which is of cast iron, is about 11 ft. long and 16 in. in diameter. It is perforated with holes from ¼ in. to ⅜ in. in diameter, and fixed to it, as shown, is a series of beaters like the blades of an old-time paddle steamer. These blades also are perforated, as indicated in Figs. 2 and 3. In the cast-iron casing in which this revolving barrel works there is a quantity of water, as shown on Fig. 4, constantly replenished by a small jet entering from the top. The smoke passes through the pipe into the interior of the revolving barrel, and thence through the holes.

The result of the beating of the water is to insure the precipitation of all the carbon and sulphur in the smoke or fumes. The barrel, driven by belt gearing, makes from 180 to 200 revolutions per minute. Over the chamber are semicircular coverings or gratings, shown in section in Figs. 2 and 4, and on plan in Fig. 3. These are simply to prevent the water or carbon finding its way to the upper part of the shaft. The hot vapor given off readily passes through the perforations and up the timber trunk shown on Fig. 1, and finds its way into the chimney or stack about 50 ft. or 60 ft. above ground level.

Opportunity was afforded of ascertaining the effect of the working of this apparatus recently. The stack was giving forth smoke when the mechanism was started, and in five minutes there was a very perceptible change, while in eight minutes only a grayish white vapor was emitted, and this was easily dissipated. Dr. Heaton, of Charing Cross Hospital, made analysis of the discharged gases, and stated in his report that there was not detected any trace of sulphurous or sulphuric acid, while carbon was also entirely absent.

The residual products collected in the annihilator are utilized for various purposes. The scum passes out from the chamber as shown on Figs. 1 and 2, and into a wooden box shown on Fig. 3. Here it appears as a black and opaque bubbling liquid, the analysis of which by Dr. Heaton is given as follows:

"The liquid was slightly acid. Qualitative analysis showed the presence of copper, iron, sulphates and chlorides, and the absence of zinc and sulphurous acid.

"The liquid contained, in 100 grain measures:

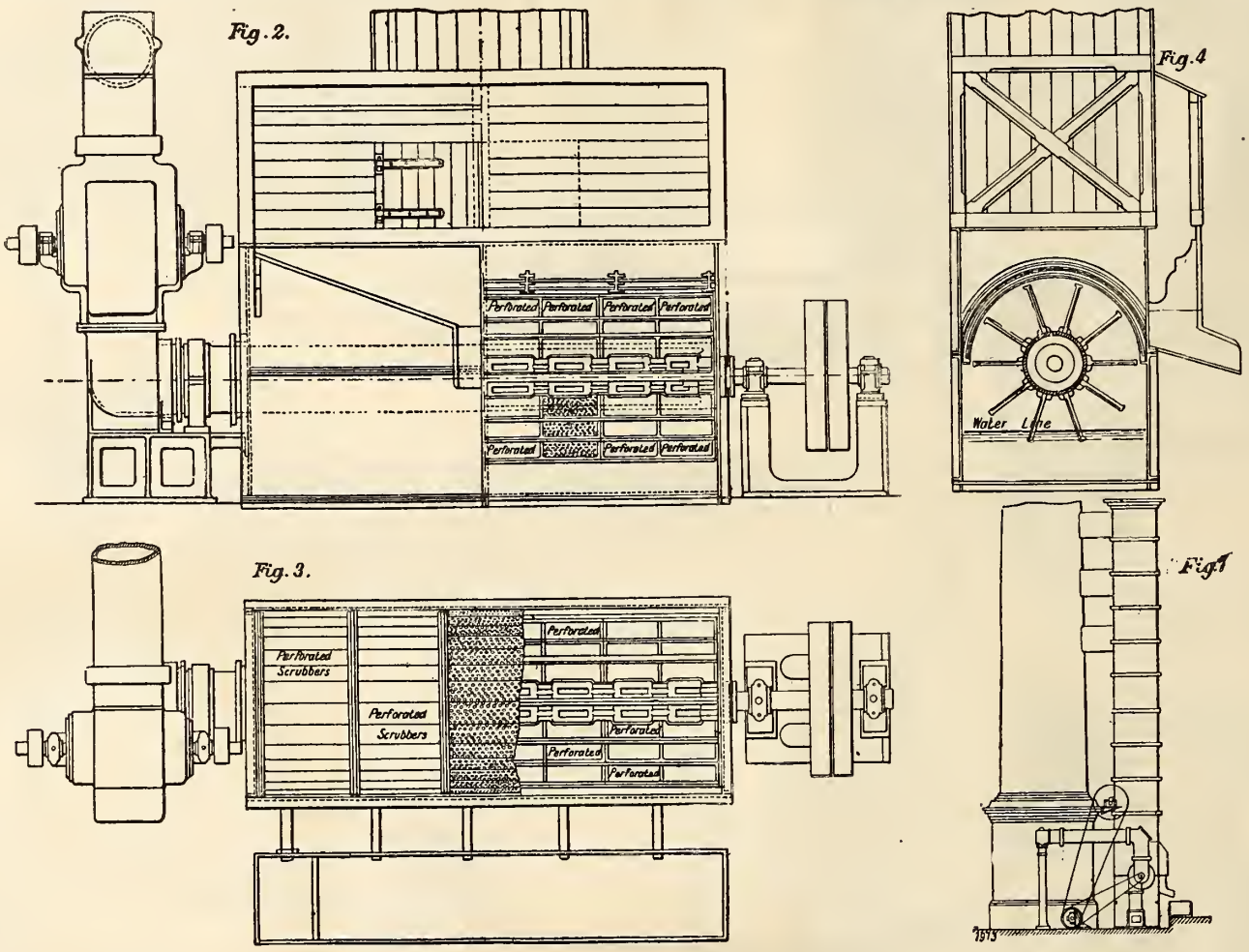
| | Grains. |
|---|---|
| Combined water and volatile matter | 0·646 |
| Ash | 0·558 |
| | 1·204 |

"Complete analysis gave the following results:

| | Parts per cent. |
|---|---|
| Sulphate of iron (green vitriol) | 0·40 |
| Sulphate of copper (blue vitriol) | 0·30 |
| Sulphate of ammonia | 0·08 |
| Sulphuric acid (free) | 0·005 |
| Insoluble organic matter | 0·022 |
| Volatile organic matter | trace |

"It is evident that the important constituents here are the sulphates of iron and copper. The following experiments were made to determine whether any appreciable quantity of tar compounds was present: 1. A portion of the liquid was shaken with ether and a little acid. The ether, when decanted and evaporated gently, yielded a residue too small to be weighed, and which, when tested, was found to contain no trace of carbolic acid. 2. Two other portions of the liquid were treated respectively with acid and with alkali. Each was distilled separately, and the distilled portions extracted with ether as before. Practically no residue was contained in either case, but the distillate from alkali after ethereal treatment developed on the watch glass a slight smell like creolin."

The liquid is drained off through a sieve, and is said to have valuable properties as a disinfectant, for which it is already sold commercially, while the carbon is used for many purposes after it is dried, notably for arc lamps. The plant at the mint is worked by a 40 horse power engine and portable boiler, which is fitted with a similar arrangement for smoke prevention, but here the vapor passes off from the annihilator into the air. —*Engineering.*




IMPROVED SMOKE ANNIHILATOR.

## THE STEREOSCOPIC LANTERN.

RECENTLY, a private demonstration of the above was given to members of the press, at Pall Mall, under the auspices of the P. S. G. B.

Numerous experiments have been made to enable a large audience to see stereoscopically pictures projected on a screen, but we believe that this is the first successful demonstration given in England.

The subject is one which is not easy to understand without full diagrams, but we must try and explain it as simply as possible without the same, as we have not, unfortunately, had time to prepare them.

In the stereoscope the great principle of relief is obtained by the right eye seeing the right hand picture, and the left eye the left hand picture. To make this more clear, we quote the following from Mr. W. I. Chadwick's "Stereoscopic Manual," which puts the case very clearly: "We will suppose a photograph to be taken of a square box. We should produce an outline such as would be seen by one eye placed in the position of the lens. Now, by removing the camera to a position two and a half inches to one side, we should produce another outline, and we see more of one side than is shown in the previous picture. Then of course these pictures are not alike, and if we caused them to overlap they would not coincide, and we should still see two different pictures, for they could not be united as one. If, now, the reader will 'use his reason rightly,' he will be able to comprehend the fact that if these two dissimilar pictures—pictures such as would be seen in nature by each eye—were to be presented to each eye at the same angle of convergence that would be necessary when both eyes were used in viewing natural objects—that is to say, if the pictures were placed side by side (at suitable distances) and the right eye photograph viewed with the right eye, and the left

FIG. 1.

FIG. 2.

FIG. 3.

eye photograph viewed with the left eye—the brain would combine them, and we should see only one as in nature; and if these conditions were fully and correctly observed, we should perceive the same solidity and relief from the pictures that is due to binocular vision when observing natural objects."

Having explained thus far, we may now proceed to explain the principle of Anderton's stereoscopic lantern. An ordinary stereoscopic transparency is cut in two and each half mounted as a lantern slide, and the two images projected from an ordinary biunial on to a screen. Now these pictures are dissimilar, as pointed out above, that is, one is a right eye (we use this term to make it clearer) picture and the other a left eye picture, and, therefore, they cannot be made to coincide, and the result is more or less of a jumble. The thing that is wanted now is some means of enabling each eye to pick out its own particular picture, and how this is done we can only explain by digressing again on to the subject of polarized light.

There are certain bodies in nature which have a peculiar action upon light. Iceland spar is such a substance, and it has the peculiar property, when a beam of light passes through it in any direction save that of the optic axis, of always dividing the light into two beams of equal intensity; and when either of these two half beams is sent through a second piece of spar, it is usually divided into two beams of unequal intensity; and there are two positions of the spar in which one of the beams vanishes altogether. On turning the spar round this position of disappearance, the missing beam appears and the other one becomes dim. The figures herewith may make this plainer. Let Fig. 1 represent two bits of spar placed one on top of the other, with their axes represented by the central line, parallel. Light readily passes through these, but let us see what will happen if we turn them round first as in Fig. 2, and finally in Fig. 3. In Fig. 2 this light begins to get dim; as represented by the shaded portion in Fig. 3 it is quite black, or no light passes through at all. The light is polarized.

Unfortunately, Iceland spar is not now to be had in any size pieces without flaws, so that we have to look about us for a substitute, and this is found in glass. If a bundle of thin colorless glass plates—the number is not of very great moment—be bound together and placed at a particular angle, which is 54° 35' to a beam of light, the bundle of plates acts like Iceland spar, and polarizes light perfectly, and therefore if we place another bundle of plates with its axis parallel to the first as shown in Fig. 1, light will pass through without any trouble, and if we turn the upper bundle, the light gradually goes through the phases of Figs. 2 and 3.

With a powerful beam of light it is not essential, to show this phenomenon, that the glass plates be in contact; in fact, provided the beam is powerful enough,

FIG. 4.

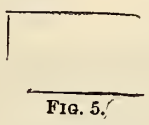


FIG. 5.

the distance between the two bundles of glass plates is immaterial. The crystal of Iceland spar, or bundle of glass plates through which the light first passes, is called the *polarizer;* the second crystal, or bundle by which the light is examined, is called the *analyzer.*

Now, possibly, having cleared the way, we may be able to explain Anderton's stereoscopic lantern. It is an ordinary biunial, fitted with lime light, and, as stated above, an ordinary stereoscopic transparency is cut in two, and one half placed in each lantern. On the front of the objective is slipped a short tube containing a bundle of glass plates We believe that Mr. Anderton uses about thirty plates, placed at the polarizing angle, and in front of the bundle is an aperture, oblong, with 1-in. sides; this forms the polarizer. In one polarizer the plates and aperture are put as shown in Fig. 4, in the other as shown in Fig. 5.

The images are projected through these in the ordinary way on to the screen, but, as stated above, will not coincide. The observer is provided with a lorgnette, which is also provided with analyzers, which are merely the bundles of glass, and these are placed in exactly the same way as the polarizers, as shown in Figs. 4 and 5, and the picture projected through the vertical polarizer Fig. 4 is viewed through the analyzer of same direction, and the same applies to the picture projected through Fig. 5.

The success of the working of the lantern was certainly striking, and this was not so good as it will be later on, because of the screen. It is a curious fact that nearly every substance that reflects light also polarizes it, except metals, and the consequence is that Mr. Anderton is obliged to use silver foil as a screen, and very well it acted. R. Field & Co., of Suffolk Street, Birmingham, are the makers of the lantern.—*Amateur Photographer.*

## PHOTOGRAPHY WITHOUT A CAMERA.

PHOTOGRAPHY offers numerous and ever new resources not only for the *utilis*, but also for the *dulcis*. We find in it an inexhaustible source of amusements, certain of which present an absolutely artistic character. Of these, we desire to give as an example, on the present occasion, only the following interesting experiments that we find in Messrs. Bergeret & Drouin's *Recreations Photographiques*. The reader will see therein how, without any apparatus, that is to say, without a camera, directly and with but a simple

FIG. 1.

frame, it is possible to obtain charming prints, some of which might really find a place in the illustrations of botanical treatises.

Photography, say these authors, offers a wide field of recreation, even to the amateur who is not provided with a camera and objective. Thus, fabrics, laces, the leaves of trees and certain flowers can be reproduced by contact, the sole *materiel* necessary being a press frame.

For all such reproductions, one contents himself ordinarily with a negative which gives in white upon a black ground the object to be reproduced.

For the reproduction of laces, it is necessary, if they have a certain thickness, to operate in open sunlight, and to hold the frame exactly at right angles with the luminous rays. This result may be easily obtained by sticking a pin, E, into the frame as shown in Fig. 1, and in so holding the frame in the hand that the shadow of the head of the pin shall be projected exactly upon the point at which it is inserted.

As regards the reproductions of leaves, it is well, before putting the latter in contact with the sensitized paper, to expose them to the sun in the frame for half an hour, in covering them with several thicknesses of blotting paper, so that they may dry sufficiently without altering the sensitized paper.

On employing ferro-prussiate paper, the manipulation of which is extremely simple and inexpensive, it is possible to make collections of leaves.

In Fig. 2 we give a reproduction of a raspberry leaf that presents a case of polymorphism, which is quite

FIG. 2.

frequent, and results from the cohesion of the upper leaflet with one of the lateral ones. The time of exposure naturally varies according to the transparency of the leaf, and the image should be attentively watched, so as to arrest it at the moment at which all the details have appeared.

For more convenience, the leaves are sometimes fixed to the glass of the frame. In the woods there are often found splendid specimens of skeleton leaves formed as a consequence of the slow decomposition of the epidermis. These skeletons form a delicate lacework which, in the press frame, gives very beautiful reproductions. It is possible, moreover, to obtain these skeletons of leaves artificially by one of the following processes: 1. First, strike the leaf, placed flat upon the knee, with a hair clothes brush. 2. Boil the leaves in a solution of an alkaline carbonate until the epidermis easily detaches itself, remove the latter with a small scalpel and then detach the parenchyma with the finger or a small brush in placing the leaf in water. Finally, dry the leaf between blotting paper.

It is possible, when the skeleton is prepared by the first process, to reserve letters or designs upon the leaf that have been cut out of paper and fixed with gum. The brush does not traverse these parts, which come out in white when the printing is done in the press frame. One can thus obtain varied effects, and employ photographs of leaves, vignettes, etc., as *motifs.*

In Fig. 3 we give a reproduction, by photogravure, of a slightly different style. The background of this has been printed by exposing an ivy leaf upon sensitized paper after preserving a blank space in the center of the leaf. The portrait was afterward printed as a vignette upon the portion remaining sensitized.—*Le Naturaliste.*

## THE "ABSOLUTE ZERO" SO CALLED.

By HENRY WURTZ, Ph.D.

THE term *absolute zero* has been in use in scientific writings and scientific parlance, and has been a factor in shaping investigation and in guiding the current of scientific thought for probably forty years past.

The term may have been introduced by Clausius or Rankine, and it may be that the original meaning was only to indicate the point of temperature at which all gaseous expansion disappears, according to the Boyle-Mariotte law, and not to signify a temperature at which all matter becomes destitute of the power to impart heat energy altogether; or in other words, a point at which matter is so cold that it cannot get any colder. Yet this latter is the sense in which the term is often applied in scientific writings. Thus Balfour Stewart (*Lessons in Elementary Physics*, p. 210) states that Clausius, Rankine and Thomson have shown that "the absolute zero" corresponds to "about —270 C. (518° F.), a point which denotes the absolute deprivation of all heat."

It appears from the context that the eminent investigators named presented this view in discussion of the theory of the steam engine; and, as above intimated, it is probably true that this temperature is that at which gaseous or vaporous expansion vanishes, which is all that concerns the steam engine.

In Watts' *Dictionary of Chemistry* (vol. 3, p. 52) is found the following: "It results from the fundamental formula (there given) of gaseous expansion

$$pv = J(a + t);$$

$v$ being the volume of the given weight of the gas at temperature $t$ and under pressure $p$; J and $a$ being constants—that, if the temperature of the gas were reduced until it became $= -a = -273°$ C. (523½° F.), the gas would cease to have any gaseous elasticity—the product of elastic force into volume would be = 0. The temperature —273° C. is, therefore, called the absolute zero of temperature, and temperatures reckoned from



FIG. 3.

it are called *absolute temperatures.* These are obviously obtained in any case by adding 273° C. to the number of degrees by which the temperature is expressed on the Centigrade scale; and by employing them in the expression of the laws regulating the relations between temperature and other properties, the resulting expressions are often much simpler than those required when temperatures are expressed according to any ordinary thermometric scale."

The latter part of this is rather vague. The fact that expressions are simplified by the adoption of the temperature of the lower limit of gaseous elasticity—

admitting that —273° C. is such—appears to be in itself no reason for calling this the "absolute zero," or the temperatures reckoned from it "absolute temperatures." These terms, except in so far as they apply to gaseous elasticity, are nothing but expressions of hypotheses, and the only term that is justifiable, in a truly scientific sense, is that —273° C. may be, and probably is, the zero of gaseous (and vaporous) elasticity. The present writer, sixteen years ago, in 1877, writing for *Johnson's Universal Cyclopedia* (vol. iv., p. 1547), demurred to this term, saying that he believed the "so-called absolute zero of temperature" to be "probably only that temperature at which the most incondensable of our *gaseous* bodies—doubtless hydrogen—would lose its gaseous form and become a liquid."

Since this date, *hydrogen*, *oxygen*, *air*, and other gases then as yet uncondensed, are stated to have at length yielded to improved methods, and given liquid condensed products. No reliable statement has, however, been met with by the writer as to the temperature at which this was effected in the case of hydrogen, or rather of the temperature of ebullition of liquid hydrogen.

But assuming that liquid hydrogen turns out to be the liquid that boils at the lowest temperature of all, and even assuming further that this temperature turns out to be at or near —270 or —273° C., would this prove such temperature to be the "point which denotes the absolute deprivation of all heat"? Has not this liquid, like water and all other liquids, its latent heat of liquefaction? Further, suppose we deprive it of this latter, and get solid frozen hydrogen. Has not this in it yet all the potential heat energy that it evolves when it *burns*, after having received back again, in addition, its latent heat of fusion and its heat of gaseous elasticity? To the writer it appears that it would be quite as reasonable to say that if we start with vapor of paraffine wax, and condense it to melted paraffine, we have reached the absolute zero. We have certainly reached the absolute zero of elasticity of the vapor of paraffine wax. If now we dip into the melted paraffine a piece of cold iron, the latter gets warm, receiving heat from the liquid, and the liquid itself chills and solidifies into paraffine wax, which has in it still all its heat-evolving potentiality, just as it had in the form of vapor at first; and, in point of fact, it is itself partly solid hydrogen. Would any one deny the possibility, if we had attained to perfect command of nature, of dipping in like manner into liquefied hydrogen a body colder than itself, which would receive from it heat, chilling the hydrogen into a solid form?

The writer urges that this term, this misnomer, "absolute zero of heat," so much in vogue, should be altered to *absolute zero of gaseous elasticity*, and thus limited to its probable or possible actual significance.

## ANIMALS OF THE TCHAD.

IN his recent mission to the upper Oubanghi, Mr. Dybowski had an opportunity of observing a certain number of animals, a few of which we figure herewith.

One would be greatly deceived were he to believe that the forests of Congo are filled with the songs of birds. They are, for the most part, silent, and it is rare that the song of any little bird is heard during the day. It is only when night supervenes that noises are heard on every hand. These are due to great flocks of gray parrots that all alight upon the same tree, which serves them as a perching place for the night, and which they leave in the morning in quest of food in the fields, and also to horn-bills (Fig. 4), which take flight in uttering strident cries. At Lyranga one observes at night legions of large bats (Fig. 1), with a spread of wing of 32 inches, that gather a fig in their rapid flight and carry it off with them. Their evolution is so prompt that they do not stop, so to speak, and it is not a very easy thing to bring them down in their flight. During the day they all assemble upon some large tree which they have selected as a domicile and from the branches of which they suspend themselves.

The aborigines of the villages of Afourous take in abundance two animals which they hunt for as food. One of these is a small species of alligator and the other a water turtle from 16 to 20 inches in length, and of about the same width. In order to keep these alive for some time, the natives bore a hole in the edge of the carapax, pass a cord through it and attach them to a tree.

From the Gaboon to the Congo and from the Congo to the upper Nile, the buffalo seems to be widely distributed, and, notwithstanding the immense area that it occupies, the species is everywhere uniform. It is the same buffalo (Fig. 5) that is domesticated at the Cape. The hunting of it is extremely dangerous. When it is attacked, it almost always turns upon its pursuer, and, if it is not arrested in its onset, will follow its aggressor with fury. The hunting is often followed by the death of those engaged in it

A small species of antelope (Fig. 2) not exceeding 20 inches in height at the withers, and of a mouse color, is common near Bangui. There are also phalangers (Fig. 3) met with here that are very rare in Congo. During the day, these animals remain suspended by their four limbs beneath a branch with which their gray coat confounds them and consequently renders them difficult to discover. They do not begin to move until twilight, and even then their motions are slow. At intervals they utter shrill cries, move slowly along the branches, and then suddenly take flight, sometimes to a distance of more than five hundred feet, to the summit of some large tree.

Upon the river Kemo there are some interesting animals to be procured, and, among others, specimens of potamogales with a tale extremely wide at the base. These animals seem to exist in all the rivers of Gaboon and Congo. But there are everywhere rare animals difficult to capture, and are therefore scarcely represented in European museums. It should be remarked that the zoological or botanical species that live on the banks of the watercourses have a much wider geographical range than those that are found inland.—*La Science Moderne.*

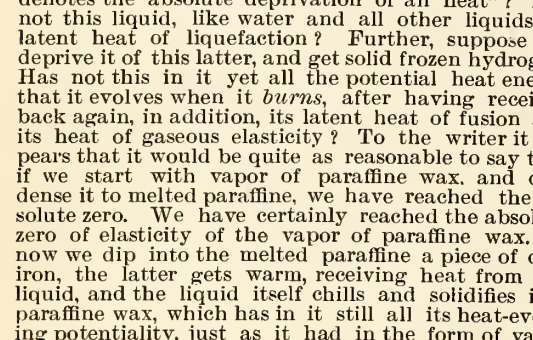


FIG. 1.—AFRICAN BATS.
(*Hypsignathus monstruosus.*)

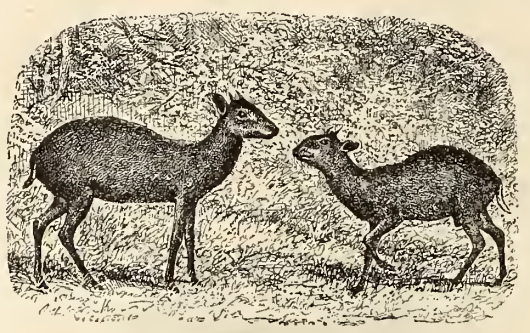


FIG. 2.—SMALL ANTELOPES.
(*Cephalophus melanorheus.*)

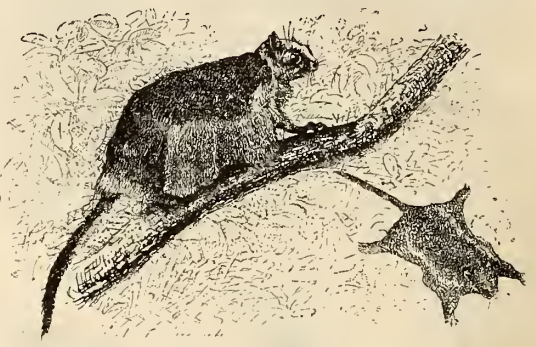


FIG. 3.—PHALANGERS OF BANGUI.
(*Anomalurus erythonothus.*)

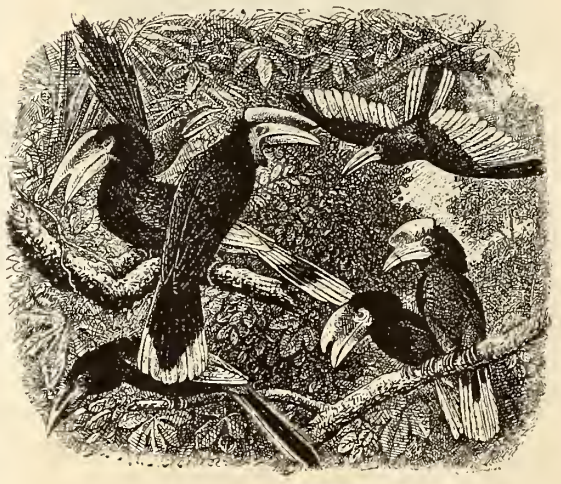


FIG. 4.—HORN-BILLS OF VARIOUS SPECIES.

FIG. 5.—WILD BUFFALO AND OX.

## SWORDFISH EXPLOITS.

SEVERAL years ago we published an account of a couple of men out in a boat, fishing in the lower New York bay, who observed a commotion among a shoal of small fish, and rowing to the spot, found what they at first supposed, by its single fin above the water, to be a shark. They attacked the monster with a view of capture, and were astonished by the sudden piercing through of their boat bottom by the sword, 4½ feet long, of a large swordfish. They succeeded in noosing his tail, securing and killing the fish, after which he was towed ashore, and subsequently brought up to the city to a restaurant in Park Row, a few doors from the SCIENTIFIC AMERICAN office. The fish weighed 390 pounds and measured 19 feet 8 inches in extreme length, It was certainly one of the finest specimens we ever saw.

The Liverpool *Mercury* gave a report from Captain Harwood, of the brigantine Fortunate from Rio Grande, to the effect that the vessel, while at sea was struck and shaken by a swordfish. After discharging the cargo at Liverpool the hull was examined and the sword of the fish found, broken off even with the outside planking. The fish had driven his sword completely through the four inch planking, leaving eight inches of the blade projecting within the vessel.

The swordfish is allied to the mackerel, which it resembles in form, and is a swift swimmer. The sword is a most formidable blade, consisting of a strong, straight bone, sharp and flat, projecting horizontally from the nose, of which it is a prolongation.

The swordfish is found in considerable numbers off the island of Martha's Vineyard, coast of Massachusetts, at this season of the year. Its flesh is considered excellent food by many persons, and the annual catch is quite large. The ordinary length of the body of the fish at full growth is 14 feet, and its sword 6 feet, or 20 feet in all.

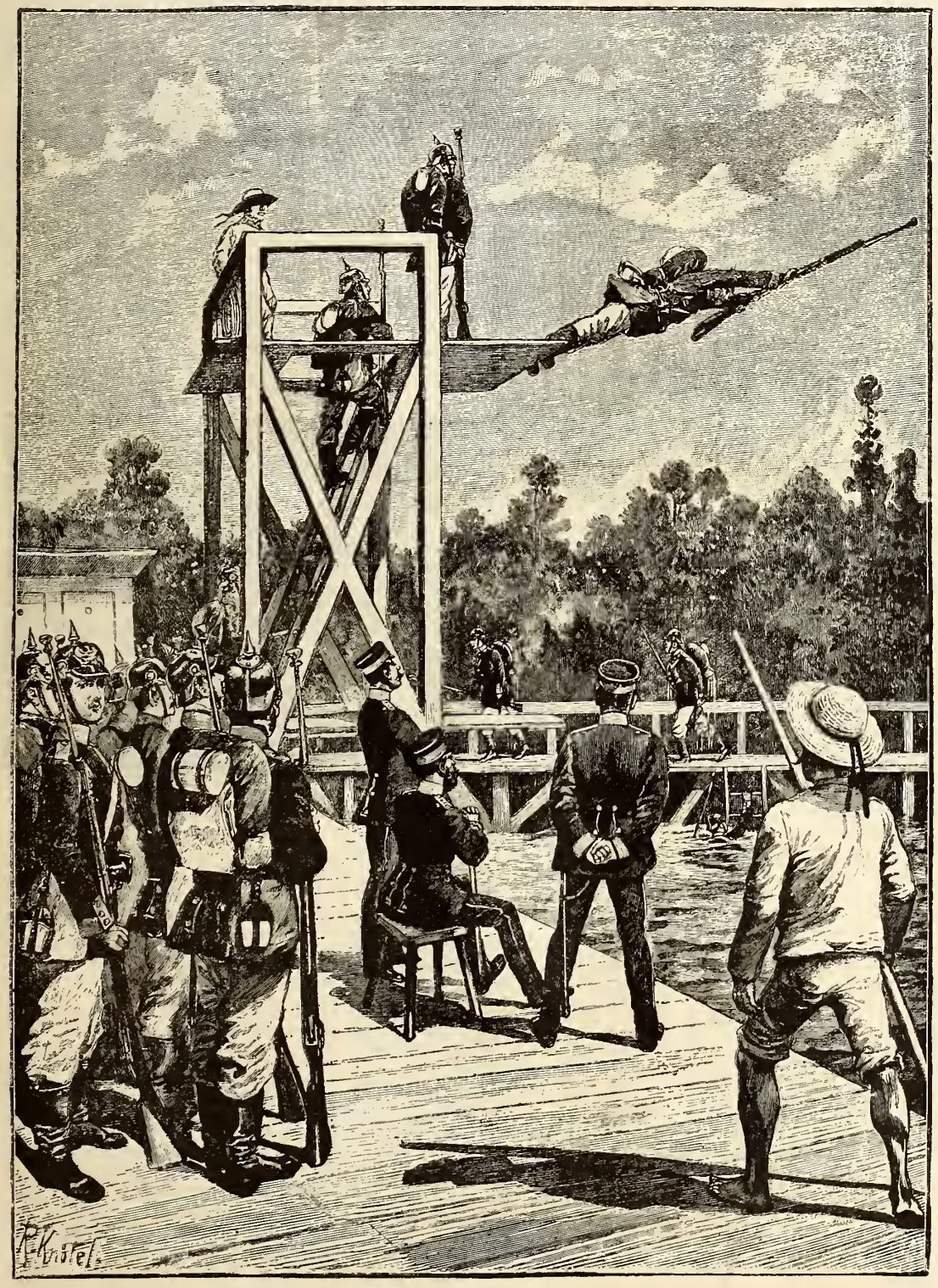
Swordfish have been unusually plentiful off this coast last summer. The fishermen hunt them with harpoons, spearing them from the decks of small sail vessels. In July last the fishing smack Mattie and Lena arrived at Stonington, Conn., after a four days' trip about Block Island, with sixteen large swordfish,

A SWORDFISH PIERCES A BOAT.

averaging 300 pounds each, and an exciting story of a struggle for life between Henry Cheesebro, one of the crew, and a wounded and maddened swordfish.

Cheesebro had harpooned a big fish off Montauk Point, and, after waiting the usual length of time, got into a small boat to bring the apparently exhausted fish to the vessel. As soon as Cheesebro approached him and commenced hauling in the line the fish awoke from his torpor and started to battle for his life. He began operations by diving so as to spear Cheesebro's boat on coming to the surface. Missing his aim, the fish dived again for a second attack.

It was now too late for Cheesebro to retreat, and defenseless, in the frail cedar yawl, he awaited the onslaught. He was kept in suspense but a moment. When the fish shot out of the water once more, he drove his sword completely through the boat from side to side. The sword entered the boat about three feet from the bow, on the port side, and came out through the thin plank on the starboard side. Cheesebro had retreated to the stern of the boat in time to avoid the violence of the fierce fish, and thus escaped injury.



SWIMMING DRILL IN THE GERMAN ARMY.

His plight was seen from the schooner, and the vessel headed for the scene of the conflict. By constant baling Cheesebro kept his frail and disabled craft afloat until succor arrived. A blow on the head finally killed the fish, and Cheesebro's peril as a sword fisherman was over for this time. The fish weighed 338 pounds.

## SWIMMING DRILL IN THE GERMAN ARMY.

FROM the time of Frederick the Great drill has always been the strong point of the Prussian army; and since the union of German-speaking states the armies of the various kingdoms and principalities which form the empire now ruled by William II. have advanced by rapid strides, until it is beyond doubt that for perfection of drill they are unsurpassed by any troops in the world. The work which this state of perfection entails on the individual soldier is very great. Every private has his copiously illustrated "Drill Book," teaching him the theory of all the steps and exercises, the practice of which he acquires under tuition on the exercise place and in the gymnasium for several hours each morning. And however ridiculous and useless some of the exercises appear to our eyes, the German soldier undergoes them cheerfully and uncomplainingly.

One of the most useful, as it certainly is one of the most interesting, of all the exercises in the German army is the swimming and diving drill as it is practiced at the military swimming baths during the summer months. It is compulsory only on the pioneers, but privates of all arms are encouraged to practice it by small money prizes and prospective promotion. The diving from a considerable height, as shown in the drawing, is best worth watching. The men taking part in it are clothed in uniforms of the oldest and least valuable description, and accoutered with "dummy" kits of precisely similar size and weight to their ordinary equipments. They are furnished with model guns and bayonets of wood, the points of the latter terminating, as may be seen, in wooden knobs. Under the direction of the military swimming master the men mount the steps leading to the diving platform in rotation, and at the word of command each takes "a header down below" precisely as is shown in our illustration, however much it is apparently opposed to English professional ideas of diving from a height.

After a more or less prolonged interval, the pioneer private "bobs up serenely," and generally (contrary to the expectation of the uninitiated stranger), without having lost his helmet or rifle and without having disarranged his accouterments, strikes out across the bath for the landing stage. The pioneers are also instructed in the towing of piles, stakes, balks of timber, and trunks of trees into position for bridge construction.

The supreme usefulness of this form of drill is very evident, and it would be well for us if our own engineers were systematically practiced in similar operations. But perhaps it would be more reasonable to expect that the seamen and marines of our fleet should be taught to swim before we demand that our army should be instructed in the accomplishment of what, we fear, many of our military authorities would be inclined to term "fancy feats." We give an illustration which will convey some impression of the manner in which this kind of drill is performed.

## THE GEOLOGICAL SOCIETY OF AMERICA.

By E. O. HOVEY.

THE sixth annual meeting of the Geological Society of America was called to order in the lecture room of the Boston Society of Natural History, Wednesday morning, December 27, by the president, Sir J. William Dawson, of Montreal. In the address of welcome by Professor W. H. Niles, president of the Boston Society of Natural History, attention was called to the comparatively great age of the Boston society. This association of naturalists is now nearing the close of the sixty-fourth year of its continuous existence, and has risen from a position of insignificance to one of great influence. A half century ago, or thereabout, it was considered a bold thing to bring Sir Charles Lyell to Boston to lecture, and that eminent geologist was mocked in the comic theaters, and the society was denounced by persons of standing. Orthodox people feared that geologists would seek to overthrow Christianity. To-day between 600 and 700 students of field geology are connected with the society annually, besides those who patronize the special lectures on the museum collection, and the large number of teachers and others who attend the regular course of lectures on geology and take a rigid examination thereon. This old society very gladly and heartily welcomed as its guest the strong though very youthful Geological Society of America, which is now only beginning its sixth year.

The programme presented to the fellows was remarkable for the number, variety and importance of the papers it contained. Fifty-nine treatises were submitted, of which forty-five were read, the remainder, for various reasons, being read by title only. The subjects treated were scattered pretty well over the whole field of geology, from Lower Laurentian gneisses to Pleistocene gravels, and discussed the matter from various standpoints, stratigraphic, paleontologic, historic and petrographic. Questions of economic importance as well as those of pure theory received careful consideration.

The reports of the secretary and the treasurer show the excellent condition of the society in every way. During the last year, fortunately, no fellows have been lost by death. The latest printed roll of membership contains the names of 233 living and nine deceased fellows. Since the issuing of this roll nine men have been received and two have resigned, while six have been dropped for continued delinquence in the payment of dues. The net membership at present, therefore, is 234. Fourteen nominations are now awaiting action by the council of administration. The treasurer received $3,859 and disbursed $3,226 during the year.

Among so many excellent papers and discussions it is hard to select what shall be presented in a brief report like the present—all were of interest and value.

The presidential address of Sir J. William Dawson was on "Some Recent Discussions in Geology," and treated in its distinguished author's most happy style theories which are now receiving the active attention of geologists throughout the world regarding continent making and mountain building. He impressed upon the society the thought that geology is a science in which it is especially true that "the goal of to-day is the starting point of to-morrow." Professor Dawson noted first the controversies respecting the age of the older crystalline rocks, the true foundation stones of continents, and stated that the basal rocks wherever found closely resemble the gneisses of the Lower Laurentian age, which attain their greatest development in Canada. These gneisses form the nucleus around which the continents have been built up.

Referring to mountain building, he said that it was necessary to specify in advance the kind of mountain under discussion. The author noted three kinds:

1. *Dump mountains* are those like Vesuvius, Cotopaxi and other volcanoes, ancient and modern, the materials of which have been brought up from below and dumped down on top.

2. *Blister mountains* rise by gentle slope without much disturbance, to considerable height, like Mount Lebanon in Syria and the Sierra Nevada in this country. Igneous ejections of later date are associated with these as a result, not cause.

3. *Crumpled mountains* show much distortion and disruption of strata. The Cordilleran mountains of the West, Appalachians, the Alps, etc., are examples of this kind. Some chains show all three kinds.

Physicists insist on a hard, rigid globe, but geology shows that the earth's crust has moved and does move. Prof. Dawson has great respect for the time-honored contraction theory, as explained by Le Conte. The expansion theory of Mellard Reade is not antagonistic to the contraction theory, but really assists it by furnishing additional force for the elevation of mountains and continents. The isostatic or flotation theory also, as propounded by Dutton, has its place. "When it is necessary to compress vast masses of rock into one-third their normal horizontal dimensions and elevate them thousands of feet above the level at which they were deposited, we may be glad to invoke the aid of all these theoretic forces and others besides."

Turning his attention to the advocates of uniformitarianism on one hand and of catastrophism on the other, as explaining the succession of strata and life in geologic history, he said that, as usual, the truth lay between the extremes. The same natural laws have prevailed from the earliest Laurentian to the present, but they have had to deal with the continents in very different stages of development, and, therefore, have produced very different results at successive periods. Furthermore, a catastrophe is often merely the culmination of slowly acting forces and is truly a part of the uniformity of nature. The slow crumbling of the face of a cliff is very gradual, but it leads to the sudden fall of vast masses of rock, exposing again new surfaces to infinitely slow decay.

Animals and plants of the abysses of the oceans are the only things which have not suffered from vicissitudes and have undergone only gradual changes. Those of shallower and littoral waters have advanced, retreated, and changed as the continents have risen or sunk. A matter of much interest in connection with paleo-botany is the evidence afforded by fossil plants as to the changes of climate and the underlying causes thereof. He showed by many illustrations how much

light fossil plants are capable of throwing on these questions and how strongly they support the idea that the vicissitudes of climate in geologic time were mainly due to the varying distribution of land and water. The areas of land and water, however, were sufficiently stable to support a continuous succession of animal and vegetable life.

The ice of the great glacial epoch was local rather than general, and there is strong evidence to show the existence of an open polar sea during the period. Prof. Dawson thinks it necessary to abandon the attempt to account for all the phenomena of the epoch by land ice alone, and that we must utilize sea-borne ice as well as glaciers. According to the best authorities, the great ice age closed but 10,000 years ago. This and other arguments suggest that vast movements of the earth's crust have taken place in periods geologically recent. The author has long advocated the probability of a great diluvial catastrophe since the advent of man on the earth, on the evidence of the extension of the northern continents in the early human period and the apparently sudden destruction of man and many of the larger animals of the Palanthropic age producing a break in life between this and succeeding ages. "This conclusion," said he, "seems now triumphant, and is beginning to bring the geological events of the later tertiary into harmonious connection with the history of early man as deduced from traditions and records."

In another paper read before the society Sir J. W. Dawson described in detail some new discoveries in the famous upright trunks of tree ferns (Sigillariæ) in the coal measure sandstone at the South Joggins, Nova Scotia. A forest or grove of these large ribbed trees was either submerged by subsidence or, growing on low ground, was invaded by the muddy waters of an inundation, or successive inundations, so that the trunks were buried to the depth of several feet. The projecting tops having been removed by sub-aerial decay, the buried stumps became hollow, the hard outer bark remaining intact. Thus they became hollow cylinders in a vertical position and open at top. The surface having then become dry land covered with vegetation, was haunted by small quadrupeds and other land animals, which from time to time fell into the open holes, in some cases nine feet deep, and could not extricate themselves. On their death and the decomposition of their soft parts, their bones and other hard portions remained in the bottom of the tree intermixed with any vegetable debris or soil washed in by rain, which formed thin layers separating successive animal deposits from each other. Finally, the area was again submerged or overflowed by water bearing sand and mud. The hollow trees were filled to the top and their animal contents thus sealed up. At length the material filling the trees was by pressure and the access of cementing matter hardened into stone, not infrequently harder than that of the containing beds. The whole being tilted to an angle of 20° and elevated into land exposed to the action of the tides and waves, these singular coffins present themselves as stony cylinders projecting from the cliff or reef and can be extracted and their contents studied. Thirty such trees have been found at the South Joggins, but none have been reported from anywhere else in the world. About fifteen of these have produced animal remains, showing the existence in the Carboniferous age of land reptiles, batrachians, land snails, millipedes, and insects

A relatively large number of petrographic papers occupied most of the attention of the society during its one day session at Harvard, Thursday. The most important of these was by Prof. George H. Williams, of Johns Hopkins University, Baltimore, on "Ancient volcanic rocks along the eastern border of North America." The occurrence of ancient volcanic rocks at various horizons along the Appalachian belt has long been recognized by some American geologists. Prof. Williams not only summarized and co-ordinated all pre-existing information on the subject, but also directed attention to many newly discovered areas of these rocks, most of which had been entirely misinterpreted by early geologists. The term volcanic should be confined to igneous rocks which consolidated at the surface which existed at the time of their extravasation. Certain criteria were given for distinguishing volcanic from non-volcanic igneous rocks, the most important of which was the association with volcanic tuff. German and other continental petrographers draw a sharp line of distinction at the beginning of the tertiary era between paleo and neo volcanic rocks, thus giving different names to rocks of the same mineral and chemical composition. English petrographers, on the other hand, rightly contend that mere difference of age should not cause us to give different names to the same kind of igneous rock. American geologists are not committed by early literature to artificial distinctions, and can and ought to make terms which describe things accurately or nearly so.

The result of Prof. Williams' personal observations and his correlation of the work of others is to establish two zones of ancient volcanoes in eastern North America. These zones roughly approximate parallelism, one along the seacoast and one along the mountains. The outer belt has been recognized in eastern Newfoundland, Cape Breton Is., along the Maine coast at Eastport, Vinal Haven and Machiasport, then in the Boston Basin and in Rhode Island. The inner and mountainous belt has been traced from Gaspe Bay through the Eastern provinces to northern Vermont, then from Harrisburg in a fine series for 150 miles to Peach Mountain, Va. A belt of ancient volcanics twelve miles wide traverses the State of North Carolina, near Raleigh, and extends into South Carolina. Prof. Williams' paper was illustrated by an interesting series of specimens of ancient (*i. e.*, pretertiary) basaltic and pumice stone from Maryland.

Prof. G. K. Gilbert, of the United States Geological Survey, gave some deductions regarding the derivation of sedimentary from igneous rocks based on the following table, which was prepared by Prof. F. W. Clark by comparing 800 analyses of igneous rocks from all over the world and obtaining the averages:

| | | | |
|---|---|---|---|
| Oxygen | 47·3 | Magnesium | 2·7 |
| Silicon | 27·2 | Potassium | 2·4 |
| Aluminum | 7·8 | Sodium | 2·4 |
| Iron | 5·5 | | |
| Calcium | 3·8 | | 99·0 |

Now the proportion of the different sedimentary rocks to one another may be roughly represented thus:

| | |
|---|---|
| Sandstone | 39 |
| Shales | 42 |
| Limestone | 19 |
| | 100 |

The oxygen of the igneous rocks is found in all the sedimentaries; the silicon mostly in the sandstones; the aluminum mostly in shales and clays; the iron in all; the calcium and magnesium mostly in the limestones; the potassium probably in the shales for the most part. Sodium is scarcely found in rocks, except as beds of salt and brines, and it is most probable that the ocean has received the largest part of the sodium set free by the decomposition of the igneous rocks. It has been calculated that there is enough sodium in the waters of the ocean to form a layer about 350 ft. thick over the surface of the land, indicating the erosion and decomposition of a sheet of rock rather more than a mile in thickness.

The point of most general interest in the paper by Prof. J. F. Kemp, of Columbia School of Mines, on the "Gabbros of the western shore of Lake Champlain," was the relation of these rocks to the Adirondack iron ores. Gabbro is a coarse-grained igneous rock somewhat resembling granite in appearance, but consisting essentially of lime-soda feldspar (labradorite) and the pyroxene known as diallage. This rock is intrusive into the limestones and schists of the Adirondack region, and carries great beds, sometimes twenty feet thick, of magnetic iron ore. This ore, however, contains so much titanium as to be worthless for smelting. The valuable non-titaniferous magnetic iron ore of the region is found in the gneisses.

In a paper on the geology of Coosa Valley, in northern Alabama and Georgia, Dr. C. Willard Hayes described some of the important economic work done by the U. S. Geological Survey in a part of the great iron producing region of the South. Iron ore can be raised, washed and delivered on the cars in this district at a cost of 90 cents per ton. The area described lies between the Rome and Cartersville thrust faults. The rocks are from Cambrian to Carboniferous inclusive in age, and present interesting stratigraphic problems in unconformities and wide lithologic variations in contemporaneous deposits. The structure has resulted from two or more periods of mountain building activity, in which the forces acted in different directions, and probably were separated by long periods of erosion.

Wednesday evening the society had a treat in the shape of a detailed description by Prof. Alexander Agassiz of an exploring trip to the Bahama Islands. These islands are typical atolls, but are not built up by coral animals from great depths, but rest on heavy limestone beds of other origin. There has been a subsidence in the region of about 150 ft., which has been made good by the growth of the corals. All the elevated portions of the islands were found to be formed of coral sand, blown up from the beach by the winds. These Æolian hills rise to the height of 350 ft. on Cat Island. The process of formation is very simple. At low tide the wind drives fragments of corals up the beach, forming dunes of sand, which the winds from N. E., S. and N. make into three series and then consolidate into simpler hills. Water percolating through the sand dissolves a part and redeposits the carbonate of lime as a cement for the rest, forming a more or less solid rock. This rock is sawn out of the quarries and used to a considerable extent for building, as it hardens on exposure to the air. There are from 600 to 650 islands in the group. The major portion of the area is taken up by great shallow banks which are indented on the east side by deep tongues of the ocean. The northern or Little Bahama bank nowhere shows a depth of more than eleven fathoms, while the Great Bahama bank is only six to seven fathoms below the surface, except at the extreme southern end, where the depth increases to nineteen fathoms.

Echoes of the discussion over the glacial period inherited from the Rochester and Madison meetings were heard in the papers by Professor T. C. Chamberlin, of Chicago, and Professor G. F. Wright on the same region, viz., the northwestern portion of Pennsylvania and the adjoining parts of Ohio and New York, with regard to the past drainage systems of the region and its glacial history. The investigations of Professor Chamberlin and his assistant, Professor Frank Leverett, substantiate the statements of Carll, of the earlier Pennsylvania geological survey, that the area now drained by the Allegheny River discharged its waters into Lake Erie through two or three channels, one of which was through French Creek and one from the Ohio River through Beaver Creek into the lake. Professor Wright claims that the rock channels of the Allegheny, Monongahela and Ohio Rivers were eroded before the first glacial epoch, which would indicate that these rivers never flowed into Lake Erie. The mooted questions are still the subject of field work which may soon settle them.

Many of the other papers read might well receive notice here, but all will appear in full in the *Bulletin* of the society and in other scientific publications.

The social side of the convention was not entirely overlooked amid so much serious business and the discussion of such knotty problems. Wednesday evening, after Professor Agassiz's lecture, the ladies connected with the Boston Society of Natural History gave an informal reception in the library rooms of the institution. Thursday afternoon, after the sessions at Harvard, President and Mrs. Eliot gave a tea. Thursday evening, at the Thorndike Hotel, the society had its annual dinner. Thirty-nine fellows participated in the dinner. As showing the tendency of American students, it is interesting to note that eleven of this number had studied petrography under Professor Rosenbusch at Heidelberg.

Late Friday evening the largest and most successful annual meeting which the Geological Society of America has held came to a close, after giving its hosts an enthusiastic vote of thanks. About seventy-five fellows, besides many visitors, were in attendance. W. J. McGee, of the United States Geological Survey, was elevated to life membership in recognition of his services to the society as editor. The following officers were elected for 1894: President, T. C. Chamberlin, Chicago; first vice-president, N. S. Shaler, Cambridge; second vice-president, G. H. Williams, Baltimore; secretary, H. L. Fairchild, Rochester; treasurer, I. C White, Morgantown; editor, Joseph Stanley-Brown, Washington. The last three incumbents held the same offices last year.

## POLYPODIUMS.

AMONG the ferns most valuable for decoration, Polypodiums occupy a prominent position. The genus is very extensive and comprises plants of small, medium, and large dimensions, adapted either for growing in suspended baskets, for pot culture, for planting out in the open-air fernery, or as edgings for the rock garden. The geographical distribution of the genus is such that it may safely be said that Polypodiums of one section or another are found in nearly every part of the globe. Besides the common Polypody (P. vulgare), which makes for itself a congenial home in the mossy bark of old trees or on the tops and in the crevices of old walls, or which we find clothing the sloping sides of our hedge banks, where it frequently forms a dense mass of undergrowth among the roots of the hedges themselves, the most remarkable species native of Great Britain are the oak fern (P. Dryopteris), the beech fern (P. Phegopteris), and the Limestone Polypody (P. calcareum or Robertianum), all well known to fern lovers. But even these species, although indigenous to this country, are of a very cosmopolitan character, the range of their habitat extending to North America and Japan.

There are a few species native of Australia and a few native of Japan, while a certain number of very distinct species are found throughout India, and a few others are native of the United States of North America and Canada. It is in Central and South America, however, that Polypodiums are most abundant and also most varied in form and in the texture of their fronds. An idea of the importance of the genus may be gathered from the fact that Nicholson, in his "Dictionary of Gardening," vol. iii., p. 186, states that "the genus Polypodium comprises upward of 460 species," and also from the numerous subdivisions to which it has been subjected by various authors. There are still a dozen of these subgenera retained by Hooker and Baker in their "Synopsis Filicum," all of which are distinguished from each other by their mode of venation or of fructification. These are Campyloneuron, Cyrtomiphlebium, Dictyopteris, Dipteris, Drynaria, Goniophlebium, Goniopteris, Grammitis, Niphobolus, Phegopteris, Phlebodium, and Phymatodes. All the foregoing, and more than forty other names which have now become obsolete, are Polypodiums, inasmuch as they have round or roundish sori (spore masses), which are naked or without indusium or covering, and composed of sporangia (spore cases) with an incomplete vertical ring.

POLYPODIUM NIGRESCENS.

With few exceptions Polypodiums are provided with rhizomes or decumbent stems from which their fronds are produced. In some species the fronds have their stalk adhering to and continuous with the rhizome, and are of an evergreen nature; but by far the greater number of Polypodiums have their frond stalks articulated to the rhizomes and are either wholly deciduous, like our own oak and beech ferns, or partly so, like our common Polypody, the beautifully purple-veined P. appendiculatum and the deservedly popular P. aureum and P. nigrescens, the former of which is illustrated in *The Garden* of February 21, 1885, while the latter forms the subject of our illustration. Polypodium nigrescens, native of Samoa, Fiji, and the Malay Islands, is also found in several localities in Southern India. It is a strong-growing species of very distinct appearance, interesting through the very conspicuous and ornamental nature of its spore masses, which, being sunk in a deep cavity, are prominent on the upper surface, a character which is shared by several other species of robust growth, principally P. subauriculatum and P. verrucosum.

All these and other kindred species thrive in a minimum temperature of 55 in winter, and in a lofty structure, where room can be afforded, nothing can be more beautiful than a hanging basket of P. subauriculatum. Speaking of this handsome species, native of Malaysia and the Philippine Islands, Schneider, in his "Book of Choice Ferns," vol. iii., p. 220, states that "in the center of a warm conservatory it surpasses all other ferns in elegance, and where there is plenty of height to allow the fronds space to hang, a specimen with numerous fronds each 10 feet to 12 feet long is a sight not easily forgotten." The same author also indicates another use for this plant when he says: "This fern can with great advantage be utilized for covering dead trunks of tree ferns; in such positions it makes a very beautiful object and grows apace, as it delights in sending its roots and rhizomes into partly decayed vegetable matter."

Among the strong-growing kinds of either erect or semi-drooping habit which show themselves to greater advantage by being planted out in the rockery I may

mention the glaucous P. aureum and its variety sporadocarpum, Billardieri, fraxinifolium, heraclæum, irioides, musæfolium, ornatum, Phyllitidis, subpetiolatum, etc. Among the species of medium growth particularly attractive through either the singular shape or the pleasing nature of their foliage, the most distinct are P. angustatum, appendiculatum, chnoodes, drepanum, fossum, heteractis, lingua and its crested and contorted form corymbiferum, Meyenianum, platyphyllum, vulgare cambricum, elegantissimum, and pulcherrimum, and also the very singular P. xiphias.

Of the dwarf-growing Polypodiums best known in gardens, the most useful and attractive are P. accedens, acrostichoides, adnescens, alpestre flexile, Dryopteris, hexagonopterum, glaucophyllum, lycopodioides and its variety salicifolium, piloselloides, Phegopteris, reptans, rupester, tricuspe, stigmaticum vaccinifolium, and the beautifully marked venosum, most of which make very handsome objects when grown on a pyramid of turfy peat.

A small number of Polypodiums, such as our oak and beech ferns, are provided with rhizomes of a slender nature, which delight in running underground in partly decayed vegetable matter, but in the majority of cases the rhizomes of either a fleshy or of a woody nature prefer being kept above or close to the ground, to which they have the faculty of adhering very firmly. The Polypodiums best adapted for pot culture are those in which the fronds are produced from a central crown; although those provided with underground rhizomes may be managed equally well in pots or planted, according to their native habitats, either in the stove, cool rockery, or outdoor fernery. The soil which suits these best is a compost of one part leaf mould or fibrous peat, two parts fibrous loam and one part silver sand.

For those species which are provided with rhizomes of a more or less woody nature, which keep near or even on the surface of the soil, a material of a different nature is required, and they have been observed to grow more luxuriantly in a mixture in which good fibrous peat or half-decayed leaf mould predominates and with a small portion of fibrous loam. In their case no silver sand is required. The propagation of the species provided with rhizomes may take place almost at any time of the year by division, while the others are most rapidly increased by means of spores, which in the majority of cases germinate freely when sown in heat and soon after they are ripe. It is worthy of notice that the plants raised from seed are usually of better shape than those of the same species produced by division of the rhizomes.—*The Garden.*

## ALLOYS.[1]

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

*Lectures I. and II.*

THE following pages will form the third series of Cantor Lectures which it has been my good fortune to deliver before this Society. In the first,[2] the "Alloys used for Coinage" were dealt with, while in the second,[3] an attempt was made to collect into as concise a form as possible the main facts connected with the history of our knowledge of the constitution of alloys, and with certain of their industrial applications.

It may be well to devote the present lectures to a consideration of the investigations to which alloys have been subjected during the five years which have passed since the last course was delivered, and it may at once be stated that the progress has not been inconsiderable. This progress is chiefly manifest in two directions. First, much light has been thrown on the particular grouping of associated metals; and, second, new alloys, new associations of metals that is, have been discovered which possess great scientific interest as well as industrial value. In no way has the advance been more marked than in the successful attempts of investigators to connect the behavior of alloys with ordinary compounds and solutions, more particularly with the solutions of salts, and the success which has been attained may be mainly attributed to the improvements in methods of measuring the high temperatures which are usually required to effect the solution of metals in each other. The whole question of the molecular constitution of alloys is intimately connected with our possession of means for investigating their thermal behavior during the passage from the molten to the solid state, from the solid to the liquid, and, finally, to metallic vapor. A brief description of the various appliances which can be used in such investigations may, therefore, well be given here, because the gradual development of pyrometry is intimately connected with the history of alloys, and, conversely, alloys have rendered great service in pyrometry. Attention will, however, be limited to the consideration of those forms of appliance which have either marked distinct stages of advance or have actually remained in use—it may be with much more or less modification— for the purposes of research.

The earliest pyrometers were essentially theromoscopes, and although their graduation presented great difficulties, the importance of being able to measure high temperatures has been recognized for centuries, and it would be difficult to illustrate this better than by a brief record of the testimony which has from time to time been offered by those who have had to apply the heat of furnaces in research or in industry; and it is mainly for the sake of the light incidentally thrown on the progress of research that the following historical notes are offered.

In the eighth century Geber, the chemist, wrote a treatise on furnaces, and showed that he was familiar with the means of applying heat; but he points to the difficulties that are met with in conducting operations at high temperatures, and these he attributed to inability to measure heat, his actual words being, "*sed quoniam non est res ignis, quæ mensuari possit.*"[4]

[1] Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

[2] *Journal*, No. 1,651, 1884.

[3] No. 1,873, 1888.

[4] From the edition of his works, "Summa Perfectionis Magisterii," published in Venice 1542, p. 28. There is some doubt whether in mediæval translations additions have not been made to Geber's text.

The date of the invention of the ordinary thermometer is not well fixed; the conception of the instrument being variously attributed to Drebbel, Santorio and Flud; but I gather from a delightful article lent me by my friend, Prof. S. P. Thompson,[1] whose authority in connection with the early history of science is beyond question, that the claims of Santorio[2] are supported by Borelli[3] and Malpighi,[4] while the title of Drebbel is considered as undoubted by Boerhaave[5] and Musschenbroek.[6] Flud repeatedly draws the common air thermometer in his singular work,[7] "De Philosophia Moysiaca."

The earliest air thermometer I can find with a movable index is described by Robert Boyle, and consists of the ordinary glass bulb with a slender stem, in which a globule of mercury moves with the expansion or contraction of the air in the bulb.

In Waller's translation of the proceedings of the Academia del Cimento figures of many other ancient thermometers will be found.

The one here reproduced (Fig. 1) is perhaps the most

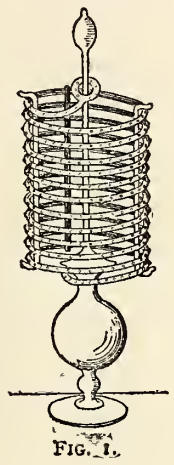


FIG. 1.

remarkable. Some readers of this may have shared with me the good fortune to have seen the actual instrument, which was exhibited in 1877 at the Loan Collection of Scientific Apparatus.[8] It consists of a lower bulb from which a long spiral proceeds and terminates in a smaller bulb at the upper end of the instrument. It is described in the account of the experiments made before the Academia del Cimento as being "of so exquisite a sense that the least flame of a candle" affects it.

I have elsewhere called attention[9] to the fact that Boyle alludes to Cornelius Drebbel as having invented "an automatous musical instrument and a furnace which he could regulate to any degree of heat by means of the same instrument."[10]

Space will, however, only permit me to refer to one instrument of singular interest from its relation to later appliances described in this paper. It is a recording thermometer, which appears to have been devised by Dr. Cummings,[11] of Chester, about the year 1803. It is shown in Fig. 2, in which *a* represents

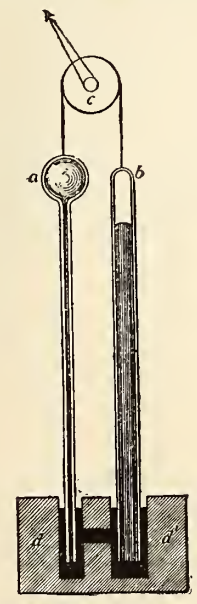



FIG. 2.

an air thermometer, and *b* a barometer suspended from the opposite side of a wheel, *c*, to compensate the influence of variations in atmospheric pressure on the instrument; *d*, *d*, is a siphon cistern in both sides of which the mercury will always remain on the same level; *f* is an index to which a pencil may be fixed for tracing the variations of the instrument on a plate revolving by means of clockwork.

I believe this to be the earliest instrument by the aid of which a time temperature diagram could have been traced. Mr. Kewley devised an instrument, patented in 1816, in which a differential mercurial thermometer was fixed to the beam of an ordinary balance.

[1] "Library of Useful Knowledge," article, "Thermometer and Pyrometer."

[2] Comment. in Galen. et in Avicen.

[3] "De Motu Animalium," prop. clxxv.

[4] "Opuscula Posth.," p. 30.

[5] "Elementa Chemiæ," tom 1, p. 152.

[6] "Elem. Phil. Nat.," section 780. Tentam Exp. Acad. Cim.

[7] "De Philosophia Moysiaca." Folio. Goudæ. 1638.

[8] See Catalogue of the Collection, No. 1828.

[9] "Proc. Roy. Institution," 1892.

[10] "Boyle's Works" (Shaw's edition), vol. iii., p. 38, 1738.

[11] "Library of Useful Knowledge," loc. cit., p. 46.

Hitherto thermometers[1] capable of measuring very moderate temperatures have alone been considered, and it is now necessary to turn to the consideration of true pyrometers, or instruments capable of indicating temperatures beyond the range of the ordinary mercurial thermometer. I have not found reference to earlier work than that of Sir Isaac Newton,[2] who, in 1701, applied his law of cooling to high temperatures, and in notes which accompany his *Scala graduum caloris* showed that he knew that the freezing point of lead differs slightly from its melting point.

Amontons made similar experiments in Paris at about the same time. Musschenbroek's pyrometer was constructed in 1731. He employed the expansion of a metallic rod for indicating the temperature to which the rod was raised. An early copy of his instrument was exhibited at the Loan Collection of Scientific Apparatus, 1877, and was, undoubtedly, one of the oldest of its kind.[3] Very many instruments of similar construction followed, but these must be passed over, as the principle on which they depend has practically been abandoned in accurate modern pyrometry. Reference must, however, be made to Josiah Wedgwood.[4] The measurement of the contraction of clay at high temperature was the basis on which his instrument rested, and, in communicating a description of it to the Royal Society, we find him, a thousand years after Geber had held that "fire cannot be measured," still lamenting the want of suitable instruments, saying, "How much it is to be wished that the authors (to whom he refers) had been able to convey to us a measure of the heat made use of in their valuable processes; . . . a red heat, a bright red and a white heat are," Wedgwood adds, "indeterminate expressions, and even though the three stages are sufficiently distinct from each other, they are of too great latitude, and pass into each other by numerous gradations which can neither be expressed in words nor discriminated by the eye."

Guyton Morveau (1808) saw the value of this appliance, and strove to reconcile the discrepancies which were discovered in working it. As regards date, the physicist who next deserves mention is Antoine Cesar Becquerel;[5] his contributions to electro-pyrometry were very noteworthy. In 1826 he used various thermo-couples, especially one of platinum and palladium, and he showed that even two wires of platinum of different manufacture could be employed. He actually measured, with the aid of a thermo-couple of fine wires, the temperatures of different portions of a luminous flame, and he fully recognized that when iron is used as one element of a thermo-couple, its behavior is abnormal. His couples were simply joined without solder.

Prinsep[6] was the first to use an air thermometer with a metallic bulb. He was the assay master of the mint at Benares, and appears to have been struck by the necessity for measuring variations in the temperature of the muffle used in assaying. He says, "the disparity of heat in different parts of the same muffle is greater than might have been supposed;" and, in view of the importance of the operation of assaying, he points out that "it would be useful to know every difference in this respect." Prinsep had already attempted to determine high temperatures by the use of a graduated series of alloys of gold and platinum—a method which is still in use—and he suggested the adoption of an optical pyrometer, in which the relative intensity of light from various sources was measured by interposing plates of brown mica between the eye and the glowing body.

In 1836 we come to Pouillet, whose work Barus, a distinguished authority on pyrometry, justly says is of prime importance. He constructed an air thermometer, with a bulb of platinum, which enabled him to work at very high temperatures. "He took the first definite step in radiation pyrometry by investigating the temperature at which solids glow; in calorimetric pyrometry, by determining the specific heat of platinum between 0° and 1,200°; and in thermo-electric pyrometry, by carefully calibrating a thermo-couple of platinum and iron."[7] In accepting this just tribute to Pouillet's work in thermo-electric pyrometry, we must not forget the earlier labors of A. C. Becquerel.

Pouillet's paper[8] is interesting reading, but it will be quoted here for the sake of its incidental references to practical work. He clearly shows that he suspected that gases are absorbed by platinum, and thus anticipates much later work; while, as regards the industrial value of the thermo-couple in pyrometry, he says: "This pyrometer offers the advantage of being a really practical instrument, and its sensibility augments as the temperature rises. When it is graduated by the air pyrometer, it is suitable for indicating, with great exactitude the temperature of any furnace, provided it is below the melting point of iron, that is, below the melting points of one of the elements of his couple." The facts stated in this sentence are, after a lapse of more than half a century, being generally accepted.

Joule[9] saw how useful the thermo-couple would be as an instrument of research, and actually employed a copper-iron one for measuring the heat which is evolved when a bar of metal is subjected to tensile stress. The early use of a thermo-couple for such a

[1] We are greatly influenced by heat and cold, and it is perhaps natural that the names of Celsius, of Fahrenheit, and of Reaumur, which are intimately connected with instruments for measuring variations of temperature, should be prominently remembered, even by unscientific persons, who have but little idea of the real nature of the work of these experimenters. In illustration of the fact that these names are household words, it may be worth while to quote the reply given by a youthful candidate to the question, "Describe any way in which the velocity of light has been measured." The answer, which Dr. Oliver Lodge ("Literary Blunders," by H. B. Wheatley, 1893, p 185) assures us was actually given, was as follows: "A distinguished but heathen philosopher, Homer, was the first to discover this. He was standing one day at one side of the earth looking at Jupiter, when he conjectured that he would take sixteen minutes to get at the other side. This conjecture he then verified by careful experiment. Now the whole way across the earth is 3,072,000 miles, and dividing this by 16 we get 192,000 miles a second.... P. S.—I think the gentleman's name was Romer (Reaumur), not Homer; but any way, he was 20 per cent. wrong, and Mr. Fahrenheit and Mr. Celsius afterward made more careful computations."

[2] "Phil. Trans. Roy. Soc.," vol. xxii., p. 824.

[3] It was constructed after the description and drawing given on p. 12, table xxx. of Musschenbroek's "Tentamina Experimentorum Naturalium," Lugduni, 1731. Par. II.

[4] "Phil. Trans. Roy. Soc.," vol. lxxii., p. 305.

[5] "Ann. de Chim.," vol. xxxi., 1826, p. 371.

[6] "Phil. Trans. Roy. Soc.," 1828, p. 79.

[7] Barus, "United States Geological Survey." Bulletin 54, 1889.

[8] "Comptes Rendus," vol. 3, 1836, p. 782.

[9] "Phil. Trans.," vol. 149, 1859, p. 91.

purpose is so interesting that a sketch from Joule's paper is given in Fig. 3, and shows the way the thermo-couple is inserted in the test piece. With reference to the use of iron in a couple it may be observed that Edmond Becquerel[1] appears to have been aware that

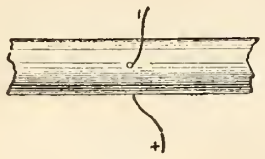


FIG. 3.

there was a critical point in iron, for he abandoned the use of the iron-platinum couple, because he found that the indications were disturbed between a temperature of 500° and 700°. We know now that one critical point in carburized iron does lie between these temperatures. He finally adopted the platinum-palladium couple, and his determinations of the melting points of silver (960°) and of gold (1092·2°) show less divergence than those of other experimenters from the figures now accepted.

Returning to Pouillet's work, it should be observed that the interdependence of the indications afforded by the air thermometer and by the thermo-couple is the basis of much work that followed. The air thermometer and the thermo-couple may really afford concurrent and equally trustworthy testimony in the measurement of high temperatures, but the difficulty of obtaining this testimony gave rise to the long controversies between E. Becquerel, who used the thermo-couple, and Deville[2] and Troost, who advocated the adoption of the porcelain bulb air thermometer. The discussion concluded with the graceful words of the latter physicists.[2] "Nos nouvelles déterminations de la température d'ebullition du cadmium et du zinc, au moyen des thermomètre à air, sont presque concordantes avec les nombres qui ont été publiés par M. Edm. Becquerel, et cet accord avec ce savant physicien nous donne quelque confiance dans les expériences dont nous publions plus haut les résultats."

Let the reader study the classical work of Deville and Troost conducted with the air thermometer between the years 1863 and 1880, comparing it with the admirable researches of Edmond Becquerel, and then turn to a recent paper by Professor Barus[3] on "The calibration of the platinum, iridio-platinum, thermo-couple,"[4] by the aid of a porcelain bulb air thermometer of refined and elaborate construction, and it will be evident how greatly scientific progress would have been promoted if the accuracy of the views of A. C. Becquerel and of Ponillet had been verified earlier. There was much intermediate work of great interest in this period, 1863-1880, of which space will not permit a detailed account to be given. It is, however, impossible to be indifferent to the scientific progress which was made in the early part of this critical period in the history of pyrometry. A picturesque and almost romantic incident is connected with the work of J. J. Waterston, and it has been well described for us by Lord Rayleigh, who found a paper by Waterston in the archives of the Royal Society, in which he clearly enunciated, in pre-Maxwell days, the kinetic theory of gases. I have referred to Waterston because the fortunate circumstance of his having had, as he says, "to graduate a water thermometer,"[5] appears to have led him to the singularly advanced view that "the ultimate molecule, as an integral part of a gas or vapor, is capable of subdivision." "It is daily becoming manifest," he adds, "that the elementary molecule, though minute beyond conception, is to be studied as a microcosm essentially dynamical in its internal constitution, its apparently statistical condition being simply the antagonism of transcendent *vis viva* potents." He points to the fact that "the forces at the command of the chemist are insignificant in comparison to the heat and pressure with which the elements of matter have to contend in the body of the sun." Surely a very remarkable sentence, since justified, not only by Lockyer's work, but by the abandonment of iodine vapor in pyrometry which followed Victor Meyer's evidence as to its being dissociated at high temperatures.

(*To be continued.*)

## THE PREPARATION AND PROPERTIES OF FREE HYDROXYLAMINE.

A CONSIDERABLY improved method of isolating hyroxylamine is described by Prof. Bruhl, of Heidelberg, in the current *Berichte*, by which a tolerably large quantity of the pure substance may be prepared without danger in a short space of time, and which may therefore be of general interest on account of its suitability for lecture and demonstration purposes. It may be remembered that M. Lobry de Bruyn, who first isolated solid hydroxylamine two years ago (*vide Nature*, vol. xlv., p. 20), prepared it from a mixed solution of the hydrochloride and of sodium methylate in methyl alcohol. This solution, after removal of the precipitated common salt, was first concentrated over a water bath, under the diminished pressure of 100 mm., and afterward subjected to fractional distillation over a flame at the still lower pressure of 40 mm. A continuous fractionating vacuum apparatus was considered unsuitable, and the change of receivers could only be conveniently effected by temporarily arresting the distillation. This mode of operating frequently led to violent explosive decomposition of the heated hydroxylamine, and, moreover, the yield rarely exceeded 17 per cent. of the theoretical. Prof. Bruhl, desiring to obtain a considerable quantity of the pure base for spectrometric purposes, has been led to devise the following much more convenient method:

The methyl alcohol solution is first separated from the precipitated salt, and then immediately transferred to a slightly modified form of the well-known apparatus of Prof. Bruhl for fractional distillation *in vacuo*. This apparatus consists essentially of a distilling flask, provided with thermometer and entrance tube furnished with tap, a condenser, and a receiving arrangement which provides for the repeated and rapid change of receiver without impairing the vacuum and without arresting the distillation. This receiving arrangement consists of a short but wide cylinder of stout glass, into which the end of the condensing tube is introduced through a tubulus fitted with bored caoutchouc stopper. Inside the cylinder is a circular stand carrying six receiving tubes, which are capable of rotation by means of a rod passing, gas-tight, through a tubulus and its caoutchouc stopper in the top of the cylinder, and terminating in a handle outside. By suitable manipulation of the handle, each of the six receivers may be brought beneath the end of the condensing tube in turn while the distillation is proceeding. The distillation of the methyl alcohol solution contained in the distilling flask is effected by reducing the pressure to the lowest possible amount, and supplying the necessary heat by immersing the flask in a bath of hot water. On account of the explosive character of hydroxylamine, it is dangerous to employ even a small naked flame, which is liable to effect local superheating. The temperature of explosive decomposition lies in the neighborhood of 130°; by uninterrupted distillation in the manner indicated, and at a pressure not exceeding 22 mm., the hydroxlamine passes over entirely at a temperature of 56–57°, and by maintaining the water bath at only a few degrees superior to this temperature all danger of explosion is avoided. The methyl alcohol is practically entirely removed by the pump. Instead of leading the distillate through a warmed condenser, as recommended by M. de Bruyn, a practice which materially diminishes the yield by decomposition of a portion of the product, Prof. Bruhl finds it much more advantageous to feed the condenser with a constant supply of iced water; for although the melting point of hydroxylamine is 33°, it does not resolidify even at temperatures only a few degrees above zero, so that stoppage of the condensing tube does not occur. It solidifies instantly, however, in contact with a vessel immersed in ice and salt. The cylinder containing the receivers is therefore immersed in such a mixture, so that each drop of hydroxylamine solidifies the moment it enters the receiver. The hydroxylamine thus obtained in one operation is substantially pure. From 30 grammes of the hydrochloride about 10 grammes of the base may be obtained in one hour, a yield of 66 per cent. of the theoretical, which is four times that obtained by the method of M. de Bruyn. In the case of hydroxylamine becoming a commercial preparation, on account of its extraordinarily great antiseptic power, it would be quite easy, by introducing suitable additional condensers, to recover the whole of the methyl alcohol employed.

The pure white crystalline hydroxylamine melts according to the mode of heating and the size of the containing tube at 32–34°, and its boiling point for a pressure of 22 mm. is 56–57°. It may actually be cooled below 0° without solidifying, if allowed to remain at rest; but, like most other substances which exhibit the property of superfusion, it solidifies the moment it is agitated. In the solid state it does not appear to be liable to decomposition. Even in the liquid state at 0° indications of decomposition have not been observed. At 10°, however, bubbles commenced to form in the liquid, and at 20° a continuous evolution of gas, mainly nitrogen, occurs, becoming more and more violent as the temperature rises, until sudden explosion takes place. Hence in a warm summer hydroxylamine cannot be preserved in sealed glass tubes. Thus a specimen, after keeping for eight days in July, was found to be no longer capable of solidification even at — 6°, although there was sufficient of the base left undecomposed to explode with a certain amount of violence upon heating, less, however, than in the case of freshly prepared hydroxylamine. When just prepared one drop warmed in a test tube over a flame explodes with a report equal to that of a gun shot. It is suggested that hydroxylamine might be safely preserved in metallic vessels, for it appears likely that the notable action of the liquid upon glass causes the commencement of the decomposition.

At the temperature of 23·5° the relative density of pure liquid hydroxylamine is 1·2044. Its refractive index at the same temperature varies from 1·4375 for light of the wave length of the red lithium line to 1·4514 for light corresponding to the blue hydrogen line H$\gamma$. The substance thus exhibits a small refractive power and a surprisingly small dispersion. Indeed, its molecular dispersion is about the same as was found by Prof. Bruhl for nitrogen itself in triethylamine, so that the atom of oxygen and the three atoms of hydrogen would appear to exert no dispersive action, if the same value for nitrogen be assumed to be equally operative. The only possible explanation is that the nitrogen here united to oxygen and hydrogen possesses a lower spectrometric constant than when attached to carbon in triethylamine. From a systematic study of the spectrometric constants of the free base, and of the methyl derivative $CH_3NH.OH$ prepared by his assistant, Dr. Kjellin, an account of which was given in the Notes of *Nature* of November 9, Prof. Bruhl has been enabled to prove two important facts. The first is that the constitution of hydroxylamine can be none other than

$$\begin{matrix} H \\ H \end{matrix}\!\!>\!N-O-H.$$

The second is that the molecular refraction and dispersion of the nitrogen present in these compounds is the same as that of the nitrogen in ammonia gas, much lower than that of the nitrogen in triethylamine, and that the probable values of these constants of nitrogen linked in this manner, for sodium light, are respectively 2·495 and 0·072. This addition to our knowledge of the spectrometric constants of nitrogen will be of invaluable aid in unraveling the intricate subject of the constitution of the class of nitrogenous organic substances known as "oxims," a subject upon which Prof. Bruhl is now concentrating his attention.—*A. E. Tutton, in Nature.*

[1] "Comptes Rendus," vol. 1, 1835, p. 28. *Ibid.*, vol. 58, 1863, p. 49.

[2] "Comptes Rendus," vol. 90, 1880, p. 777.

[3] "Phil. Mag.," vol. 34, 1892. p. 1, and *ibid.*, p. 376.

[4] This couple was first used in 1873 by Tait. "Edinburgh Roy. Soc. Trans.," vol. 27, 1873, p. 125.

[5] See his paper, "Phil. Mag.," 1863, vol. xxvi., p. 116.

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POPE LEO XIII.

FROM THE PAINTING FROM LIFE BY CHARTRAN.

## PORTRAIT OF HIS HOLINESS THE POPE.

WE give on our first page an engraving of the magnificent portrait of his Holiness Pope Leo XIII. painted from life by the distinguished artist Theobald Chartran, which attracted great attention in the salon of the Champs Elysees, Paris. This is said to be the first and only portrait painted from life of the Sovereign Pontiff, and represents in the most artistic manner the benign features and general expression of goodness which so habitually enlightens the face of the Holy Father. Our picture is from *La Ilustracion Española.*

## PHOTOGRAPHS IN NATURAL COLORS.*

Produced by the Improved Process of L. Lumiere, after Professor Lippmann's Interference Method.

By LEON WARNERKE.

THANKS to the great kindness of M. L. Lumiere, of Lyons, we are able to examine to-night the latest results obtained by him. A few explanatory remarks are necessary to make the method of their production generally intelligible. About two years ago Professor Lippmann, of the Sorbonne, in Paris, succeeded in producing photographically a colored image of the solar spectrum, based on the well known principles of interference. He used for that purpose a plate coated with an albumen, collodion or gelatine sensitive film. This sensitive film was, during exposure, brought into contact with metallic mercury, the image of the spectrum being projected on the film through its glass support. The light, after penetrating through the thickness of the film, was reflected back from the surface of the mercury, the direct light waves encountering the waves of reflected light, producing the phenomenon of interference in the thickness of the film. The waves of light propagating in opposite directions cause the vibrations at certain intervals to be neutralized, while at others they are intensified. If such a plate could be developed, fixed and dissected, we should find it to consist of strata of the black deposit of silver, produced by the developer in the parts corresponding with the maximum of light, succeeded by transparent strata corresponding to the minimum of light where the developer had no action. The distance between the strata is equal to half the wave length, which is 600 ten-thousandths of a millimeter for red light, 583 for orange, 551 for yellow, 475 for blue and 423 for violet. In a film $\frac{3}{10}$ mm. thickness there will be about 200 such strata. It is evident that on examining such a plate by reflected light we shall observe the colors, because it is formed of a series of films of the thickness requisite to produce color sensations. Subsequent experiments proved that by using a gelatine film sensitized with a chromium salt, a similar result is obtained, the action of interference producing strata of soluble and insoluble gelatine.

The exposure of the plates produced by Lippmann was very long, and, owing to the variation of sensitiveness of different rays of the spectrum, necessitated the masking of the portions exposed to the more actinic rays, while the others are exposed. L. Lumiere succeeded in producing colored images in one operation, and in last May, in a paper read before the Paris Academie de Science, gave full particulars of the process as follows:

ABSTRACT.

To prepare the emulsion the following solutions are made:

| | | |
|---|---|---|
| A—Distilled water | 400 | parts |
| Gelatine | 20 | " |
| B—Distilled water | 25 | " |
| Potassium bromide | 2·3 | " |
| C—Distilled water | 25 | " |
| Silver nitrate | 3 | " |

One-half of A is added to B and the other half to C. These two solutions are mixed by adding the silver to the bromide. A suitable sensitizer is added, such as cyanine, methyl violet, erythrosine, etc., and after filtration plates are coated on a tourniquet at a temperature of 40° C.

When the emulsion is set the plate is immersed in alcohol for a very short time and washed in a continuous stream of water. The film being very thin, the washing is soon effected. This emulsion should not be washed in bulk, lest coarseness of the particles of silver produced by reheating results, and in order to have the films as transparent as possible; for the same reason a great excess of bromide is to be avoided. The plates are dried, and just before use are immersed for two minutes in

| | | |
|---|---|---|
| Water | 200 | parts |
| Silver nitrate | 1 | part |
| Acetic acid | 1 | " |

This bath helps to produce brilliancy of the image and to increase the sensitiveness. But the plates cannot then be kept long, because the sensitive surface soon deteriorates. When the plate is dry it is ready for exposure *a la* Lippmann, viz., with a reflecting surface of mercury next to the film.

For the developer the following solutions are made:

| | | | | |
|---|---|---|---|---|
| I—Water | 100 parts | | | |
| Pyrogallic acid | 1 part | Sol. I | 10 | parts |
| II—Water | 100 parts | Sol. II | 15 | " |
| Potassium bromide | 10 " | Sol. III | 5 | " |
| III—Ammonia D. 0·960 diluted to 18°. | | Water | 70 | " |

The degree of concentration of the ammonia has a great influence on the result, even a slight alteration destroying the brilliancy of the colors. For fixing, the plate after washing is immersed for from 10 to 15 seconds in a 5 per cent. solution of potassium cyanide, washed and dried.

In order to lessen the action of the ultra-violet, violet and blue rays, a parallel-faced bath of Victoria yellow, uranin or primuline is used in the camera.

The pictures lent by M. Lumiere are 6 by 8 cm. in size, and when seen at a certain angle show colors of unsurpassed beauty—beyond anything we are accustomed to see in the way of the reproduction of colors—somewhat metallic in appearance, but very bright and of very decided and definite color.

To examine them direct, the best plan is to use the reflected light of a bright sky, or if a lamp must be used, it is preferable to have the light reflected from a white shade or opal globe.

To appreciate all the beauty of these photographs, the image should be lit by a powerful light (preferably electric) and a projection made on a screen by means of a portrait lens (4 in. diameter). The result is then of such beauty as to defy description—it is not like an oil painting or a water color; it is like real nature on a bright summer's day. Seeing these first photographs in natural colors we feel we are in the presence of one of the greatest inventions of the nineteenth century, and we may sincerely congratulate our friends on the other side of the channel upon so splendid an achievement.

* From Transactions of Photographic Society of Great Britain, October 11, 1893.

## PERFUMES AND PERFUMERY.

LADIES who devote some study to the selection of delicate perfumes, and have by temperament and practice become connoisseurs in the detection of subtile and delightful odors, will be gratified to learn that this faculty is a preservative of health. When the cholera prevailed in Paris and London, all the people engaged in the work of preparing perfumes escaped its ravages, and when the Dutch destroyed the spice trees on the island of Ternate, the colony suffered from epidemics and diseases previously unknown. So those accustomed by the culture of their sense of smell to use perfumes not only find in the perfume itself a prophylactic against some forms of disease, but are themselves enabled acutely to detect the presence of noxious and poisonous atmospheres.

The increasing use of perfumery in commerce has enriched many parts of the world, and France, India, Turkey, and Italy to-day enjoy a handsome revenue from the sale of flowers and materials cultivated exclusively for this industry. It is believed by experts, notably Mr. R. S. Cristiani, of Philadelphia, that the United States is entitled to compete with these countries in the production of the articles used in perfumery. There are many sections of our country where flowers could be raised on a large scale, and capital inducements offered to enterprising men to start a new venture of this sort, where success means fortune. From the earliest times perfumes have been popular among the priests and administrators of religious rites, as they have used incense at the worship of their deities. In those ancient days the Egyptians, as in most other things, preceded the rest of the world in the use of perfumes, and from them it passed to Assyria, Greece, Rome, Arabia, and Turkey. The Asiatics, attracted by their luxurious tastes to all sorts of sensuous indulgences, found perfumes a necessary accessory in their daily pleasures. Nineveh and Babylon, according to Herodotus, consumed such enormous amounts of perfumes that, besides the production of their own country, they obtained from Arabia "a thousand talents of frankincense."

Alexander found among the spoils in the camp of Darius quantities of essences and cosmetics; and the Romans and Greeks used perfumes, and the many ointments into which they entered, most lavishly. The Orientals are addicted to musk, whose powerful odor has for them a great attraction. To such an extent is the love of perfumery carried, that there is said to be a mosque the mortar of which is mixed with musk, so that its walls become fragrant when the sun shines upon it, and the air of this temple becomes itself steeped with this penetrating scent.

Perfumes became fashionable in the reigns of the great kings and queens, and Elizabeth, Queen of Hungary, is said to have invented the famous Hungary water, by the use of which she retained her beauty until she was past seventy years of age. Perfumery exists among all races, and ranges from the Australian and Esquimaux, whose taste is vulgar and low, to the highest delicacy of perception in a Beau Brummell.

Mr. Cristiani, in his valuable work on perfumes, from which the above facts are culled, tells us that, though we obtain valuable perfumes from the East, the south of Europe is now the only reliable source of supply—Cannes, Grasse, and Nice being the principal seats of flower culture. Cannes excels in the culture of the rose, cassia, jasmine, and tuberose; Nismes in rosemary and lavender, Nice in violet and mignonette, and Sicily in the citron and orange. British India gives us cinnamon, cloves, patchouly, santal, ylang-ylang, and odoriferous gums and spices. China yields musk, civet, and ambergris. England furnishes lavender and peppermint, for which its moist climate is peculiarly adapted, while we are indebted to Italy for the citric odors, as lemon, bergamot, cedrat, limette, neroli, etc.

It is interesting to note that the odors of plants exist in different parts of them, sometimes in the wood, as in cedar and santal; sometimes in the leaves, as in patchouly and thyme, in the seeds, as in caraway and tonquin, in the bark, as in cinnamon and cascarilla, and in the roots, as in orris and vitivert. Some plants yield more than one odor. Thus the orange has three—one from the flowers, called *neroli*, one from the leaves, called *petit grain*, and another from the rind of the fruit, called *portugal* or *orange*. Perhaps the most striking and surprising method adopted for extracting the perfumes of flowers is that entitled *enfleurage*, wherein the flowers are simply planted in grease trays and allowed to remain until all of their delicate perfume has been abstracted and imparted to the oil or fat in which they are immersed, fresh flowers being added until the fat has become saturated with the aroma of the plant.

The amazing extent of this industry may be gathered from the following statistics, which represent the consumption of flowers at Nice alone, one of the most favorably situated of the perfume manufactories:

| Flowers. | Pounds. | Value. |
|---|---|---|
| Orange | 3,000,000 | $300,000 |
| Rose | 1,000,000 | 75,000 |
| Jasmine | 250,000 | 50,000 |
| Violet | 100,000 | 35,000 |
| Cassie | 150,000 | 50,000 |
| Tuberose | 50,000 | 25,000 |

The celebrated *attar of rose* is made in Turkey and India, where very extensive rose farms are situated, as at Adrianople, Uslak, and Ghazipoor.

Among the numerous perfuming materials used, the following appear to deserve mention in a cursory notice, as the most interesting in their associations, or from the singular fact that, while recognized as perfumes, they are not cultivated for the extraction of their aroma, but simply imitated by suitable compounds.

*Ambergris* is a secretion of the sperm whale. It is found floating on the sea along the coasts of China, Japan, and Greenland, and for a long time was thought to be fossil amber, from which its name is derived (ambergris), gray amber. Mr. Cristiani remarks that, while not possessing an agreeable odor itself, it imparts, with other perfumes, a remarkable fragrance.

*Heliotrope*, though immensely popular as a perfume, is imitated by perfumers by a mixture of rose and vanilla, not being expressly cultivated for the purpose of extracting its perfume.

*Honeysuckle* is another perfume imitated by the perfumer, and deservedly popular.

*Lavender* is grown extensively in England and France, and its oil is extracted by distillation. the English product being much superior.

The *Lily*, the *Magnolia*, the *Pea*, are all successfully imitated, and it is doubtful whether their admirers ever suspect that they are not enjoying the fragrance of the flowers themselves.

*Musk*, the powerful odor which evokes so much disgust among some, is invaluable to the perfumer, entering into many preparations. It is a secretion of an abdominal gland in the musk deer. The best quality comes from Tonquin. It is an unctuous substance, reddish brown in color, with a powerful and penetrating smell, which, ameliorated by combination with other odors, forms admirable compounds.

The *Rose* affords the perfumer his most valuable material for the preparation of innumerable extracts and bouquets, while the dried leaves enter into powders and pastilles.

The *Vanilla* is the bean of a handsome vine, and, made into a tincture, it enters into a great number of extracts. It grows in Mexico.

The *Violet* is the most expensive of all flower perfumes, from the smallness of the flower, but it furnishes the most exquisite fragrance, and is justly sought for with avidity. Large farms are devoted to its cultivation at Nice and Florence.

We have just touched, under the guidance of Mr. Cristiani, this wide field of technical research. The subject is one of the most entertaining interest, and one which most of the readers of this paper will realize as extremely novel.

## LOUISIANA SUGAR.

ACCORDING to the last report of the Commissioner of Internal Revenue, the following was the production for the year 1892–93 of sugar of all kinds, according to reports and estimates:

| | Pounds. | |
|---|---|---|
| Cane sugar: | | |
| Louisiana | 445,854,797 | |
| Mississippi | 3,043 | |
| Texas | 9,068,077 | |
| Florida | 215,464 | |
| | | 455,141,481 |
| Beet sugar: | | |
| California | 22,801,288 | |
| Nebraska | 3,808,500 | |
| Utah | 1,473,500 | |
| | | 27,083,288 |
| Sorghum sugar: | | |
| Kansas | | 1,026,100 |
| Maple sugar (estimated) | | 32,000,000 |
| Total production in the U. S. | | 515,250,796 |

SUGAR FROM SUGAR CANE.

There were 618 producers of sugar from cane licensed in the district of Louisiana (including one in the State of Mississippi) during the past year, 16 in Florida, and 16 in Texas; total, 650.

The total quantity of acres of cane ground and made into sugar, according to the figures furnished this office, was as follows:

| | |
|---|---|
| District of Louisiana | 180,645 |
| Third district of Texas | 4,652 |
| District of Florida | 68 |
| Total | 185,365 |
| Quantity reserved for seed | 44,287 |
| Quantity under cultivation | 229,652 |

The acreage of cane under cultivation for the coming crop, as reported by applicants for license, is as follows:

| | |
|---|---|
| District of Louisiana | 281,667½ |
| Third district of Texas | 7,060 |
| Florida | 1,213 |
| Total | 289,940½ |
| Quantity to be reserved for seed | 36,112 |
| Quantity to be utilized for sugar production | 253,828½ |

There is also a quantity of cane under cultivation by persons who take out no license to produce sugar, but sell cane or sirup produced therefrom to licensed sugar producers not included in the above statement, making probably 10,000 acres additional.

The operation of the law in relation to the bounty on sugar has had the effect so far as cane sugar is concerned to increase the production and to lessen the number of sugar factories or licensed producers.

In the district of Louisiana, where cane sugar is principally made, there were during the first season in which the law was in operation, that of 1891–92, 697 producers licensed to manufacture sugar, and the product of that period aggregated 357,875,557 pounds.

The number of producers licensed during the season of 1892–93 was 618, and the amount of sugar produced aggregated 445,857,840 pounds, an increase of 87,982,283 pounds, notwithstanding a reduction of over 11 per cent. in the number of licensed producers.

The number licensed to manufacture sugar in that district during the present fiscal year is 552. There will undoubtedly be a large increase in production over that of last year, probably 20 per cent., unless

some unusual accident, such as an early frost, should supervene.

The average price paid for cane purchased for sugar manufacture in Louisiana is said to be $4 per ton delivered at the nearest railroad station, as against $2.50 and $3 per ton in former years delivered at the factory. In some instances contracts are made on the basis of the amount of sugar that the cane will produce, one-half the product in sugar being allotted to the factory and one-half to the cane cultivator. In some localities it is the custom, in addition to a specific price per ton, to allow a certain per cent. increase in the event that the extraction exceeds a certain limit.

It is estimated that $2,000,000 have been invested in Louisiana in improved machinery for making sugar since the beginning of the present year, the full effect of which will not be seen and appreciated until the conclusion of the coming season. These changes in the machinery of sugar factories result in a more economical manufacture of sugar and indicate a gradual departure from the primitive and more wasteful methods formerly in use.

Although there were 618 licensed sugar producers in the district of Louisiana during the season of 1892-93, only 569 made sugar, of which 295 used the vacuum pan process of manufacture, 272 the open kettle process and 2 used both methods.

Of the 552 sugar producers licensed in the district of Louisiana for the current year, 299 gave notice that they intend to use the vacuum pan process of manufacture, either at the home factories or at factories not owned or operated by themselves, and 250 intend to use the open kettle process or open steam train. Three intend to use both methods, making part of their sugar by open kettle process and part by the vacuum pan and centrifugals.

The methods of evaporation are as follows: First, by the use of open kettles, over a direct fire, from two to six kettles being used. Starting from the mill, the juice is carried from the first kettle into a second, and then into a third kettle as it increases in density through evaporation until it becomes sirup of about 25 degrees Baume before it reaches the last kettle or strike pan, where it is further boiled until it shows signs of crystallization, when it is removed to cooling troughs for granulation and afterward to hogsheads with purging holes for drainage. When sufficiently purged of molasses, the product enters the market as open-kettle sugar. Second, with the process of steam train, open metal tanks with steam coils are used instead of kettles and direct heat (seldom more than three tanks are used with separate strike pans). The juice leaving the clarifiers enters the first evaporator, and as it increases in density is carried into the second, and then into the third evaporator, from which it is pumped into the strike pan at about 25 degrees Baume and boiled by further use of the coils until it shows further signs of crystallization, when it is removed to coolers and treated as open-kettle sugars. Many producers using steam trains granulate their sugar by vacuum pans and centrifugals and make first and second instead of open kettle sugar; again, many open kettle producers have separate strike pans with steam coils, and certain others boil to sirup of 25 degrees Baume and granulate by vacuum pan and centrifugals.

The third and last method of evaporation by vacuum, single, double, and triple effect, is alike in some respects to the steam train, except that the receptacles or evaporators are covered and air tight with vaccum produced through pumps, causing the juice to boil and evaporation to take place at a lower temperature, 120 to 170 degrees F., against 212 F. or over in open pans. Steam coils are also used here. The vapor of the first effect becomes the heating power of the second, and so continues through the several evaporators. This method also brings sirup to the density of 25 to 26 degrees Baume when it enters the vacuum pan for granulation.

In the classification of the sugar producers, for office purposes, there are two kinds of vacuum pan and open kettle producers; namely, those who make their sugar at factories owned and operated by themselves and those who have their sugar made at factories not owned or operated by themselves. Some producers make sirup at one factory which they own and have it granulated at another factory, often a central factory.

## WHERE COTTONSEED OIL GOES.

THE disposal of the immense output of cottonseed oil will interest those who are not familiar with this rapidly growing industry and the many uses that have been found for this most useful of all vegetable oils.

The question is frequently asked, "What is cottonseed oil used for?" Last year there were probably 1,250,000 tons of seed crushed. Out of this seed there were obtained about 1,000,000 barrels of oil.

At Chicago not less than 300,000 barrels are used for making lard. At St. Louis, Kansas City, and Omaha about 200,000 barrels are used in making lard.

The lard is made by mixing beef suet with cottonseed oil, the degree of hardness of the product being determined by the relative proportions of the oil and suet. It is notable that in much of the lard there is no hog product at all.

About 20,000 barrels are used on the coast of Maine to pack sardines.

Probably 50,000 to 100,000 barrels are used by the soap makers for making toilet soaps.

Some 200,000 to 300,000 barrels go to Rotterdam, Holland, for making butter. Large quantities go to Marseilles, France; Trieste, Austria; and various points on the Mediterranean coast, especially in Italy, for mixing with olive oil.

The poorer grades are used for illuminating purposes in mines, as a lubricant in cutting threads on pipes and bolts, and other purposes.

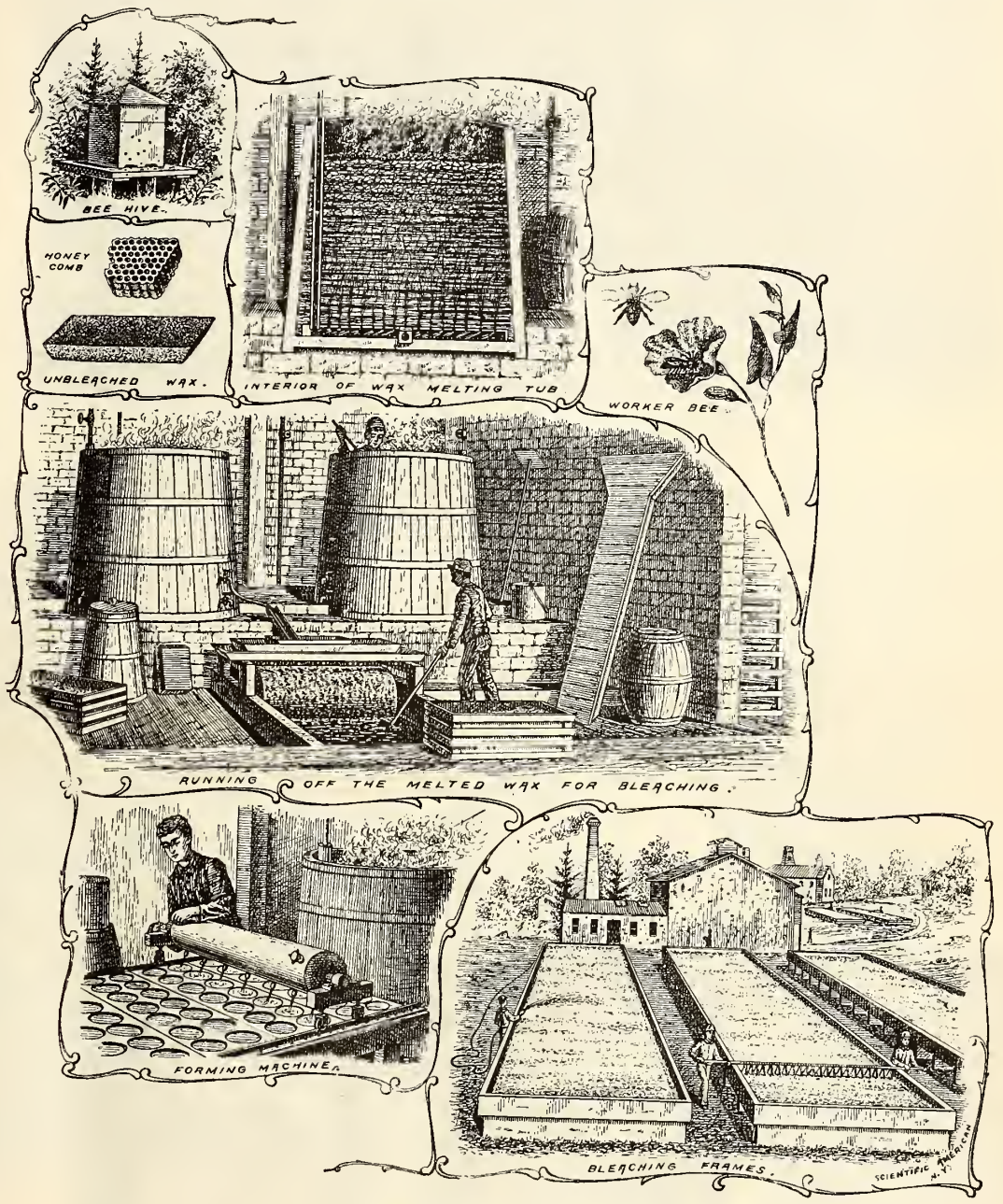
It is not a good lubricating oil, because it contains too much gum. Much money has been expended trying to find a process of refining that will eliminate the gum.

Of late years much oil has been shipped to Mexico and South America. In these Latin countries it is used as a cooking grease, without the necessity of disguising it as lard by using beef suet with it. In fact, most of the people of the earth prefer a clean vegetable oil for cooking to American fats. The Anglo-Saxons and Germans are notable exceptions.

Its use in an unadulterated condition in America as a cooking grease is rapidly increasing, especially in Texas and New England. All the restaurants in Houston, Galveston, and other Southwestern cities, and in Boston, Providence and other New England cities, keep pure refined cotton oil on hand at all times. In Boston the physicians uniformly prescribe food cooked in cotton oil as a remedy for indigestion, and the idea has grown very popular, especially in Boston and the adjacent towns and cities.—*Charlotte Observer.*

## A BEESWAX BLEACHERY.

BEESWAX is supposed to come from the stomach of the bee in the form of scales and carried to the mouth with the legs, where a frothy liquor is added to it, causing it to become plastic. In this state it is formed into the cells or comb, in which the bees deposit their honey. The combs are formed in hives built for that purpose, some of which contain colonies of bees numbering from 10,000 to 40,000. Where the climate is warm most of the year round, each hive will average between 350 and 400 pounds of honey. The greatest honey and wax producing States are New York, California, Ohio, Indiana, Illinois, Wisconsin, Michigan, Kentucky, North Carolina, and Dakota. These States produce about 800,000 pounds of beeswax yearly. About twenty pounds of honey are required to produce one pound of wax. Large quantities of wax are imported to this country in cakes of twenty-five and fifty pounds each from Cuba and Africa. It comes in two colors, light yellow and dark brown.




A BEESWAX BLEACHERY.

Bees that gather most of their honey from grape and tobacco flowers produce the dark colored wax, which is hard to bleach. That produced from clover, buckwheat, etc., is light colored and bleaches easily. The bleached wax is used mostly by sperm candle manufacturers, wax flower makers, druggists, and in the manufacture of carbon paper. The large cakes are first broken up into small pieces and put into a large circular tub or vat made of cedar. This tub is about five feet in height and about three feet in diameter. Across the bottom of the tub are two square hollow wooden pipes, one crossing the other at the center, the tops of which are perforated with a number of holes. Placed into the end of one of these pipes is a perpendicular wooden pipe, which is connected at the top to a brass steam pipe.

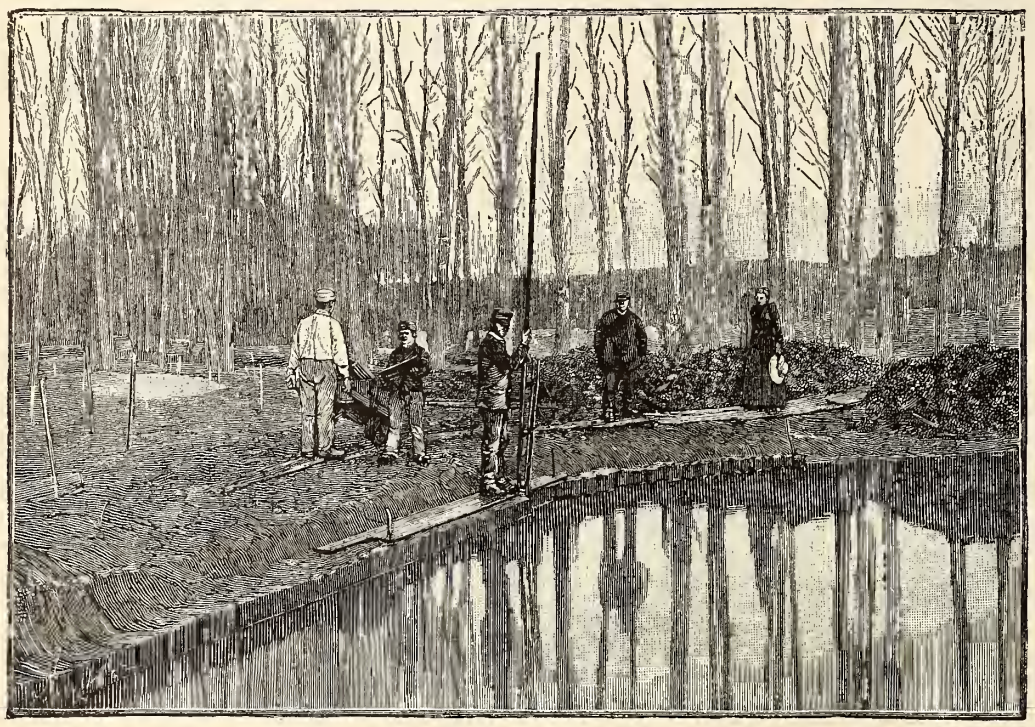
About 1,500 pounds of the wax is placed in the tub and enough water poured on to it to swim it well. From forty-five to sixty pounds of steam is then turned on, which rushes down to the perforated pipes and is forced up through the holes and distributed through the wax, which, in about three hours, becomes thoroughly melted, the dirt and grit, if any, sinking to the bottom. It is then drawn from the tub and run through a sieve, where it falls down on to a revolving wooden wheel or roller, about 4½ feet in length and 18 inches in diameter. The bottom of this roller rests in a bed of water about 18 inches in depth and about 6 feet in length, the temperature of which is about 70°. As the melted wax leaves the sieve it strikes or falls on the top of the wooden wheel in small pieces or ribbons, sticking fast and becoming instantly chilled.

This roller makes about sixty-four revolutions per minute, the wax dropping off the instant it comes in contact with the water. The material is then taken out of the water bed, by means of wooden forks, and placed in boxes and carried out to the bleaching frames. These frames are made of wood, about 100 feet in length, 14 feet in width, and about 8 inches in depth, and raised 3 feet from the ground. About 1,000 pounds of wax is placed on each frame and left out day and night for the sun to bleach for four weeks. It is sprinkled with water four to five times daily, to keep the summer sun from melting it, as the temperature reaches as high as 120°. Once a day a 64-pronged wooden rake is drawn back and forth through the material, which turns it over, allowing the sun to act on every particle. The wax when first taken out to bleach is yellow. After four weeks' exposure in the sun it becomes a creamy white. It is then gathered up and taken back to the tubs and melted over again, going over the same operation and out again to the bleaching frames, to remain out two weeks longer, with the same sprinkling and raking operation. This second bleaching turns the wax almost to a snow white, and it is ready to be formed into cakes for the market.

About 600 pounds is then melted up at a time in a tub and drawn off to be made into cakes as needed. These cakes are made by running melted wax from a horizontal movable copper cylinder into circular moulds. These moulds are of heavy tin, 4 inches in diameter and about one-quarter inch in depth, and are placed one after another on a long table, the sides of which are fitted up with tracks, over which the movable cylinder can be drawn back and forth. This cylinder is 10 inches in diameter, 5 feet in length, and double. The outer cylinder contains hot water, which surrounds the inner one, containing about fifteen pounds of melted wax. The hot water and wax are poured into the cylinders by means of capped tubes at each end. Projecting from the outside of cylinder and connecting with the inner cylinder are a number of small hollow tubes, through which, when the attendant turns the cylinder over, the wax runs out into the moulds. As soon as the moulds are filled the cylinder is drawn back again and pushed forward to the next set of moulds, the operation being repeated until the moulds are all filled. To keep the wax from cooling, the hot water is poured when cooled, and fresh added after every ninety pounds of wax has been drawn off. The moulded wax becomes cool in about one hour, and it is packed into boxes and ready for market. The sketches were taken from the plant of Theodor Leonhard, Paterson, N. J.

## THE EXPLOITATION OF TURF AT PAS-DE-JEU (DEUX-SEVRES).

THIS year the dearth of forage has directed the attention of agriculturists to the use of turf. For the litter of thoroughbred horses there has long been used a material called Dutch turf, brought from Holland at great expense. It is a fibrous substance of a yellowish color, which, exported in large 150 kilogramme bales, somewhat resembles large packages of rags. What does it consist of? What we have seen appears to contain only plants on the surface—stems of *Dicranum*



EXTRACTION OF TURF FROM BOURCANI POND, AT PAS-DE-JEU.

and *Polytrichum*, and of *Scirpus*, *Carex*, etc. Spread out and well stirred, it constitutes quite a soft bedding, of an absorbing power greater than that of straw. The use that is at present made of turf for litter offers a capital importance, and we believe it of interest to say a few words about an exploitation of some extent carried on in France—that of Pas-de-Jeu, in the department of Deux-Sevres.

The turf of Pas-de-Jeu, extracted under water, dried in the sun and crushed into coarse powder, is extremely absorbent, antiseptic and hygienic. Provided it be well stirred and well preserved, four to six hectoliters weighing 50 kilogrammes will remain clean from one to two months under a horse of ordinary stature, and afterward furnish a very rich manure under a smaller bulk than ordinary farm dung. In fact, with the turf of Pas-de-Jeu there is no flow of liquid manure in the stalls of the animals. The fertilizing part of the dung has been stored up, so to speak, by the turf, without loss to agriculture.

The subsoil and all the surrounding part of the valley of the Dive being calcareous, it is not necessary to seek therein any trace of silicious plants. The primitive other. This agglomeration of mosses has exactly the appearance of the Dutch turf, but these are surface plants. At Pas-de-Jeu, the formation of the marsh is finished, especially since the canal has been dug from Dive to Saumur. The surface, formed by a fine black earth without stones or pebbles, is covered with meadow grass, along with numerous poplars of extraordinary vigor.

In order to exploit the turf, a certain thickness (about 30 centimeters) is first removed from the surface, and by means of a special instrument called a trenching spade, a stratum of turf is cut up to the level of the water. The water is found at less than a meter in depth. It is at this moment that use is made of the large trenching spade invented in Picardy in the last century. It consists of a right-angled three-sided box about 1·5 meter in length, formed of a light open framework of sheet iron, the whole attached to a handle of oak wood of a length of 5 meters or more and that can be increased. The bottom of the instrument has a cutting edge. Besides, at the top, near the handle, upon the third and open side there is a small flexible tongue of sheet iron designed to hold the long piece of turfy substance at the moment that it is detached from the bottom. As the turf thus accumulated at the bottom of the water through ages is a soft spongy substance unmixed with sand or gravel, the instrument penetrates it with great facility.

The long parallelopipedon of turf thus extracted is laid upon terra firma, cut into three sections and placed upon a wheelbarrow. These pieces or briquettes are then carried to a short distance and placed in piles of twenty-one each. These briquettes, thoroughly hardened by the sun and crushed by a special instrument, form the litter-turf.

Our engraving represents a laborer manipulating his instrument, which he is preparing to plunge into the peat bed in order to extract a briquette of turf. Behind him may be seen a boy helper holding a briquette in his hand. Alongside of him is the barrow man, who is in the act of carrying away the briquettes that he is to pile up in the drier.

The Pas-de-Jeu turf is genuine turf in every geological acceptation of the word. It has gradually filled to repletion the ancient bottom of the valley of the Dive, at the northwest point of contact of the departments of Deux-Sevres and Vienne.

Its very nature and its chemical composition make of it a fuel, a fertilizer and an essentially hygienic litter. In fact, it possesses a great absorbing power which permits it, in neutralizing bad odors, to retain the liquid portions of animal dejections. It is especially as a disinfectant and antiseptic that it is destined to render in stables the greatest services to agriculture.

It has, besides, the important advantage of being a French product of low price, and of furnishing an extremely rich fertilizer after being used as litter.

In order to derive the best results from it, it is necessary to place under oxen, horses or other animals of large size, from four to six bags of the pulverized substance. The bags weigh 50 kilogrammes.

This litter, kept in good order by a daily stirring, will last from six weeks to two months.—*La Nature.*

## THE EXHIBIT OF THE UNITED STATES GOVERNMENT AT CHICAGO.

THE exhibit made by the United States government is certainly one of the most interesting, if not the most interesting, of all those contained in the vast buildings of the World's Fair. The defect of great international expositions, and of the Chicago Exposition in particular, is the dispersion of the objects of the same nature or relating to the same subject. Each one exhibits according to his taste and his interests, which are often entirely opposed to those of his neighbor, and the Exposition assumes, in definitive, the aspect of a fair rather than of a museum. This does violence to the impresion of the whole, and renders the general study of a given question very difficult.

The organizers of the government exhibit have endeavored to avoid this defect and have fully succeeded. They show the natural productions of the country, and, by way of comparison, the progress made by the American people since the epoch at which Christopher Columbus landed upon *terra nova*, and especially since the declaration of independence a hundred and seventeen years ago. Alongside of the historic objects and restorations may be seen the most improved modern methods. These object lessons offer a great interest.

The objects exhibited in the Government building may be separated into two distinct parts, one of them relating to the soil, its curiosities and its productions, and the other designed to make known the different services of the great American republic: War, Agriculture, Justice, Interior, Post Offices, Finances and Affairs of State.

The celebrated Smithsonian Institution and the Washington Museum have sent the most curious objects of their collections. These are clay models of natural size that represent the ancient inhabitants of America, their costumes and their occupations, and collections of birds, animals and insects. These latter merit special mention, for we do not believe that there are any in existence that are better arranged and better adapted to the education of the public. Each species is represented by several individuals of different age and sex, grouped in the attitudes that they assume in a state of liberty, while the necessary accessories make known the surroundings in which they live, the food that they prefer, the form of their nests, burrows, etc. A short description accompanies each group. The visitor can thus learn in a few minutes more than he could by extensive reading. It is very different from the dry nomenclature of certain of our museums. Some of the subjects are of rare beauty. We may mention in particular the walrus, an animal living in Behring's Sea, of which the Eskimos utilize the flesh, skin and oil. The skin, which is of considerable thickness, is utilized especially for polishing.

The center of the building, under the great cupola,

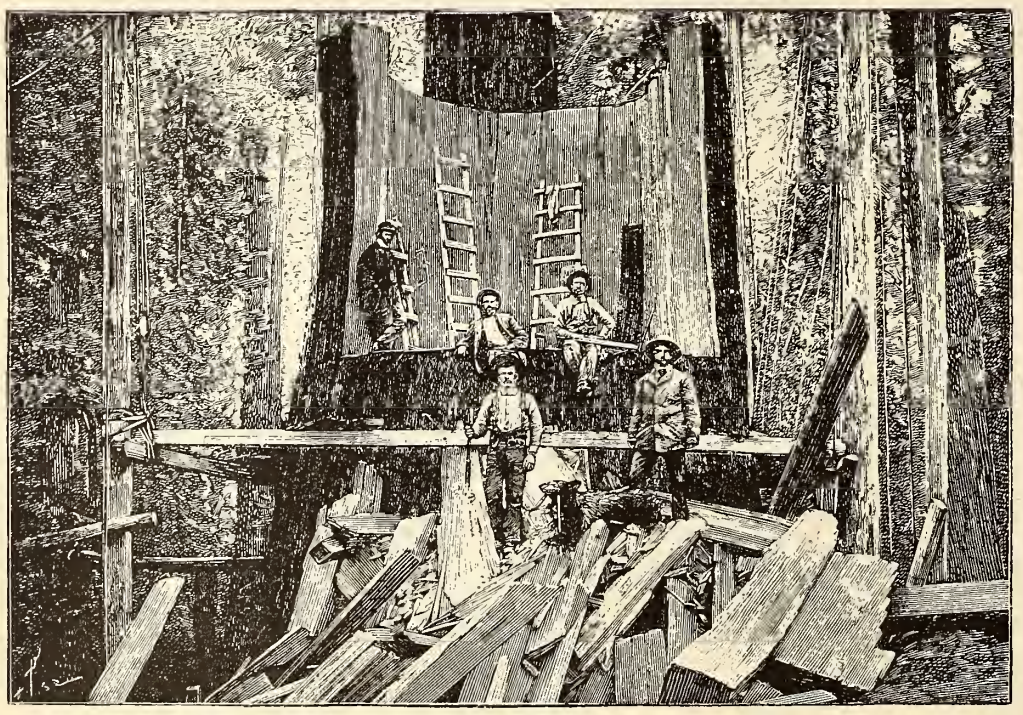


FIG. 1.—OPERATION OF FELLING THE SEQUOIA EXHIBITED AT THE CHICAGO EXPOSITION.

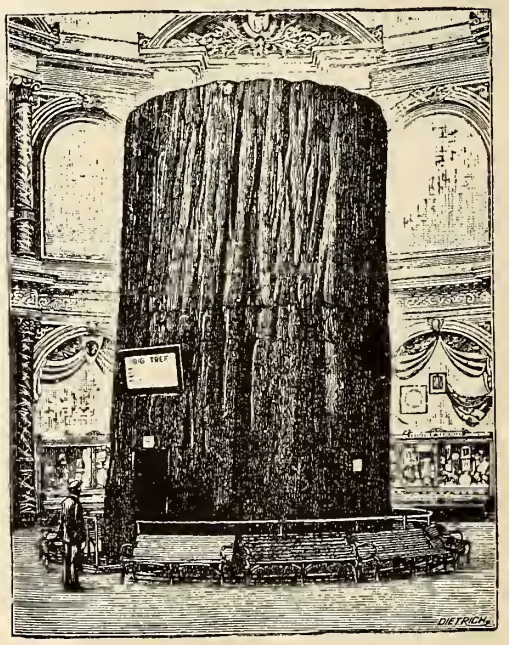



FIG. 2.—TRUNK OF THE SEQUOIA EXHIBITED AT CHICAGO.

marshes have disappeared and have been replaced by meadows. Here are met with no heaths, no sphagnum, nor any of those other mosses which in certain countries form true accumulations. At Bressuire (Deux-Sevres) and at Roche-sur-Yon (Vendee), we sometimes observe in the non-inundated marshes sorts of protuberances that rise above the surface of the earth and that are formed of nothing more than sphagna mixed in groups closely pressed one upon the

is occupied by a portion of the trunk of one of the big trees of California (*Sequoia gigantea*—Fig. 2). These trees, which were discovered in 1852 by Mr. A. T. Boyde, a hunter, soon acquired great celebrity. Their wood, which is very heavy when it is green, becomes much lighter in aging, and is susceptible of a beautiful polish. Their destruction was becoming so rapid, being given that they are no longer capable of reproducing themselves, that the govern-

ment had to take particular measures to prevent their entire disappearance. In order to preserve a specimen of them, it caused the exhibited example to be cut, to which has been given the name of "General Noble." It is 22 feet in diameter, 82 feet in circumference and nearly 30 feet in height, and forms a true cylindrical house, as shown in Fig. 2. It is the largest section of the redwood that has ever been transported. The center has been removed, in order to afford space for a spiral staircase, terminating in a platform from which the visitors can conveniently observe the paintings of the dome. The interior is illuminated by the electric light, and, around the platform, are placed photographs representing the different phases of the felling and transportation of this huge object.

The tree from which it was taken was 300 feet in height, 26 feet in diameter, and 101 feet in circumference at the base. It is one of the smallest specimens of the species. It was selected on account of its regular form. The section was made at 20 feet above the earth. It would have been impossible to transport this annular block in a single piece. So it had to be divided into 46 segments, certain of which weigh more than four tons. Eleven cars were employed for the carriage of it. Fig. 1, reproduced from a photograph, gives an idea of the system employed for the felling, as well as of the size of the tree. Four large poles were raised around the trunk, and a platform was erected at the level of the upper section. The upper part of the tree was cut down, and broke in its fall, and then the work began. A tackle block fixed to the extremity of a gin served to lower the segments. The transportation presented peculiar difficulties. As these trees are found sufficiently tall in the mountains only, it became necessary, in fact, to travel a distance of nearly sixty miles before reaching a railway station. This journey could be effected only by wagons constructed especially for the purpose, to which were harnessed sixteen mules. The felling and carriage to the railway cost alone $7,500.

The Post Office Department exhibits drawings and models representing the old processes of letter carrying in different countries, alongside of a postal car provided with all the recent improvements, and a complete post office. This office is entirely surrounded with glass. It is open to the public, which can thus follow all the operations necessary for assuring the rapid and sure carriage of correspondence. This department exhibits likewise a collection of different postage stamps and of curiosities derived from what the Americans call the "Dead Letter Office."

Alongside of letters not delivered for want of sufficient address (and certain of these addresses are so ingenuous that they would make a collector happy) are observed a number of objects sent through the mail, up to living snakes and others preserved in alcohol! In each case the address has been put upon the object, and sometimes, even, the letter accompanying the sending has been added with the hope that among the visitors some one might be found who would recognize the lost articles and be able to claim them. Alongside of the coins and stamps of the present time are exhibited those that were employed at the time that the thirteen States formed the nucleus of the nation. Not far distant are exhibited the lighthouses and luminous buoys employed in the United States, but which for the most part are of French construction.

Upon a bracket, above delicate and complicated reckoning machines, are exhibited the old election returns of a time when the compilation of the ballots was easier than the throwing out of the votes deposited in the ballot box of a district. One can see all the mechanical calculating arrangements, and four men are employed in running the machines.

Above this space there is suspended one of the largest geographical globes ever constructed. It is twenty-two feet in diameter and makes one revolution per minute. By a skillful arrangement it is lighted internally by electricity, and the water, earth and letters are projected with intensity in different colors when the sphere is revolved.

In the southwest corner is the exhibit of the Secretary of War. From the ceiling are suspended all the flags and standards of the army, with the signals that serve for communicating orders in times of maneuvers. The visitors can see the cannons of old times alongside those of the present, and the pieces of artillery that Lafayette offered the nascent nation in the last century alongside of gigantic modern guns and electric torpedoes. A row of machines run by expert operators make cartridges, firearms and blank arms for the "boys in blue." Wax figures illustrate the different uniforms of the service. Plans, models and photographs make known the great work executed by the army engineers of the country.

The exhibit of fisheries is very complete. The zoological stations, the exploring boats, with their apparatus of observation and the results obtained, the fishing apparatus, from the rude bone hook employed by the Indians up to the most improved fish hook, as well as all the models of nets, harpoons and dredges employed by professionals or amateurs, are represented in these collections.

The section of pisciculture shows us the apparatus for collecting and transporting fishes' eggs and fecundating them, models of hatching apparatus for heavy eggs, of medium or slight density, with eggs in different stages of advancement, from the moment of depositing to that of hatching.

In all these exhibits, numerous drawings and photographs permit of following all the phases of the transformation and the results obtained everywhere where the apparatus were too cumbersome to carry without presenting a sufficient interest. This permits of following exactly the plan of the whole, while at the same time avoiding useless repetitions.

Finally, we shall mention the exhibit made by the Patent Office of the models of apparatus patented in America. Among the enormous number of inventions of which the citzens of free America have desired to guarantee themselves the proprietorship, the selection was not easy. The plan adopted gives this exhibit a peculiar value from a historical point of view. Thus, in the showcase in which is exhibited the first electric telegraph invented (a cumbersome and massive apparatus made almost entirely of wood) are placed thirty models showing the important improvements that have led to the creation of the almost perfect modern apparatus. As the Americans receive all their dispatches by sound, without preserving any trace of the transmission, the printing and autographic apparatus are a revelation for many in the United States. It is to be regretted that alongside of the form that the apparatus possessed at the time of its invention the present practical form of the same apparatus is not represented. Those inventors, and they are legion, who think that it suffices to have the principle of an invention in order to make it a success, and gain glory and wealth therefrom, would have found salutary instruction. They would have seen how much work it requires in order to practically realize inventions, even the best. It is difficult, for example, to recognize in the first Hughes telegraphic apparatus the present apparatus under the form that Mr. Fremont has given it. And it is the same way in many other cases.

Nearly 3,000 models are exhibited! They relate to gas, air, steam and electric motors, to machines for working wood and metals, to combing, carding and weaving machines, to arms, to machine tools, to sewing machines, etc. All the models selected are grouped in such a way as to completely illustrate the development of a same idea.

The government exhibit is completed by a meteorological bureau, with registering apparatus, a life saving station, and a naval exhibit contained in a reproduction of a ship of war constructed expressly for the Chicago Fair.—*La Nature.*

THE SONNEBERG TOY CHARIOT.

## THE SONNEBERG TOY CHARIOT.

THE exhibit of Germany at the Fair was very comprehensive, all of the great industries being adequately represented. In toys Germany leads the world, and Nuremberg has been called the toy shop of Europe. At the Fair the two most remarkable exhibits of toys were made by the town of Sonneberg and by the cities of Nuremberg-Furth, who combined their exhibits, as they are situated only four miles apart. Sonneberg is a town of Saxe-Meiningen and is situated twelve miles northeast of Coburg. Nearly the whole population of Sonneberg, which numbers over seven thousand, is engaged in the manufacture of toys, musical instruments and wooden ware. The dolls of Sonneberg have a world-wide reputation, and many thousands of the flaxen-haired little Gretchens delight the children of America every Christmas. The Sonneberg chariot in the German section, Manufactures building, which we illustrate, was a carved and gilded creation filled with dolls and delightful animals of the higher grade. On top is St. Nicholas, with traditional pack and beard, while just below a tidy German nurse maid is seen with her charge. This chariot was a never-ending source of delight to the children. The drawing, for which we are indebted to the *Illustrirte Zeitung*, was made by the German artist, E. Limmer.

## A NEW SYSTEM OF VEHICLES.

ALL of our readers are acquainted with the inclined plane horse mills that have been so extensively used in recent years. An inventor has conceived the idea of applying this apparatus to the propulsion of all kinds of vehicles upon roadways. The principal advantage that he calculates on deriving from this arrangement is that the horse, being situated in a box closed on every side, there will be no fear of those frequent accidents caused by fright. Moreover, as the transmission of the work produced by the horse to the vehicle is effected through the intermedium of a gearing, the pilot can, at the least warning, throw the mill out of gear and tighten a brake, thus producing a much quicker stoppage than can be effected in the present style of vehicles.

Our engraving will allow the operation of the system to be understood.

The horse stands in a box, A, whose inclined floor consists of an endless chain, B, passing over two cylinders, C, situated at the two extremities of the box and supported throughout its length by rollers, *a*, revolving over tracks, *b*. The axis of the front cylinder carries along, through the intermedium of the bevel gearings, *c c*, of the shaft, D, and of the gearings, *d e*, the shaft, E, which revolves in one direction or the other, according as we throw into gear with the wheel, *d*, one or the other of the pinions, *e*, both loose upon the shaft.

Two wheels, *f* and $f_1$, keyed upon this shaft and gearing with two others, *g* and $g_2$, keyed upon the shaft, F, transmit the motion to this latter with different speeds, according as we have thrown into gear the pair of wheels, *f g*, or the pair, $f_2$ or $g_2$.

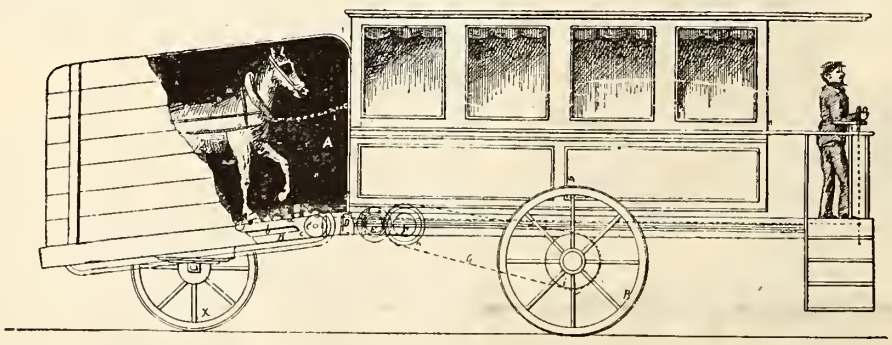
Finally, this shaft, F, actuates the wheels, R, of the vehicle by means of the pitch chains, G and $G_1$, passing over the toothed wheels, *h i* and $h_1$, $i_1$. Coupling boxes, *l* and $l_1$, permit of isolating one of the wheels at a given moment, this being indispensable in order that the vehicle may be able to turn.

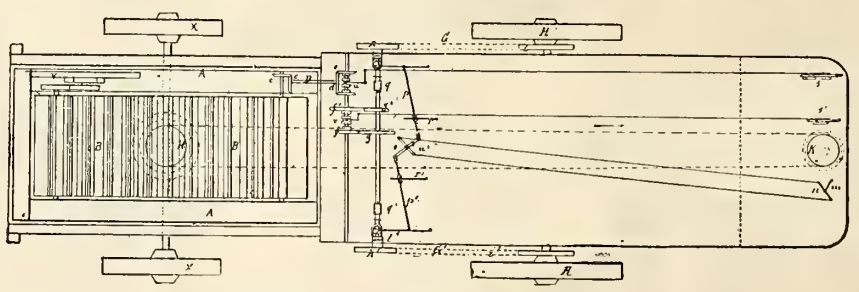
The axle of the hind wheels, X X, is mounted upon a bolster pin, and the motion of turning out is produced by acting upon the toothed disk, H, by means of a chain passing over the wheel, K, whose axis carries a hand wheel which is maneuvered by the pilot.

The two gearings, *l* and $l_1$, can be thrown out of gear simultaneously by turning the crank, *m*, whose axis carries a side lever, *n*, connected by rods with the lever, $n_1$, which is connected with the lever, *o*, that acts upon the connecting rods, *p* and $p_1$, controlling the two coupling boxes. These latter are moved back to their initial position by springs or by counterpoises, *q* $q_1$.

The ungearing of one or the other of the gearings, *l* $l_1$, takes place automatically when the bolster pin of the hind axle is acted upon. To this effect, the chain controlling the toothed disk, H, acts, for example, upon the bent lever, *r*, which carries along the connecting rod, *p*. As the eye that serves to connect the latter with the lever, *o*, is elongated, the connecting rod, $p_1$, is not influenced. In this case, the bent lever, $r_1$, does not act any more upon the rod, $p_1$. The control of the gearings, *u* and *v*, of the shaft, E, is effected by means of rods or wires ending at the hand levers, *s* and $s_1$.

Finally, the apparatus is provided with a fly wheel (not shown in the engraving), around which winds a brake band, controlled likewise by the pilot, and which serves to stop the movable inclined plane in case of accident.—*Les Inventions Nouvelles.*





NEW SYSTEM OF VEHICLES.

## GAS MOTORS IN GERMANY.

THE following is from the official report to the State Department by our consul-general to Germany, Mr. Frank H. Mason:

Prominent among the economies which have been introduced during recent years in Germany is the use of gas motors in place of steam engines in all the smaller forms of manufacture where the motive force required does not exceed 75 to 100 horse power. At the Frankfort Electrical Exposition of 1891 most of the dynamos were driven by gas and caloric engines, and the display of these motors at that time was almost as varied and interesting to the general public as that of the electrical apparatus to which they were technically subsidiary.

There were in operation at that time throughout Germany about 18,000 gas motors, with an aggregate motive force of 60,000 horse power. Since then the gradual cheapening of gas and the rapid extension of electrical lighting and electrolysis have combined to increase very rapidly the use of gas motors, the effectiveness and economy of which were so brilliantly demonstrated at the Frankfort Exposition. No statistics are available to show the precise number that are at present in use, but, as the two principal makers of gas engines in Germany have alone made and delivered during the past two years 1,950 motors, it may fairly be inferred that the number in actual service in this country is not far short of 24,000 or 25,000.

Meanwhile the progress that has been made in improving the machines and increasing their economy has been quite remarkable. The first gas motors, which were exhibited and used experimentally about 1868, were fatally extravagant. The Lenoir machine, which was the best model known to Germany as late as 1861, used—according to a recent statement in *Kuhlow's Trade Review*—1,235 cubic feet of gas per horse power per hour, whereas the motors now in use consume only 28 feet per horse power per hour in small machines, and in large sizes as low as 23·75 feet; so that 21·2 cubic feet of gas per hour will run an incandescent lamp of 16 candle power, and this proportion is said to have been reduced in large plants which employ motors of 500 horse power and more to 17·6 cubic feet of gas per horse power per hour.

How economical such a motive power must be for all the smaller forms of manufacture, and especially for electrical lighting by isolated plants, will be apparent from the following tabular statement of the price per 1,000 cubic feet of gas which prevails at present in the principal cities of Germany:

| | |
|---|---|
| Altona, Bremen and Mayence | $1 36 |
| Brefeld (with discount to large consumers) | 1 32 |
| Brunswick, Bonn and Strassburg (without discount) | 1 21 |
| Magdeburg, Leipsic and Breslau (with discount) | 1 21 |
| Barmen (with discount) | 1 19 |
| Dantzic and Dresden | 1 14 |
| Berlin and Konigsberg (without discount) | 1 09 |
| Cassel, Dortmund, Elberfeld and Hanover (with discount) | 1 09 |
| Frankfort (with discount) | 1 07 |
| Stettin, Essen and Cologne | 1 02 |
| Bochum | 95 |

In some of the above named cities gas is made and furnished by the municipality, in others by private companies chartered and managed similarly to private gas companies in the United States. In Frankfort the field is occupied by two companies—one English, the other German—which have parallel mains on all principal streets and supply for the above-stated price gas of uniformly excellent quality. When it is remembered that the coal for the manufacture of gas in this city is brought from England and the Ruhr district of Westphalia, it will be apparent that for two rival companies to prosper in a city of 180,000 inhabitants by selling gas at $1.07 per thousand it must require good management and the employment of the most improved methods. As a matter of fact, the cheapness of gas here, as elsewhere in Germany, is the direct result of the skill and care with which all the subsidiary products of coal distillation—tar, ammonia, etc.—are saved and utilized.

[Continued from SUPPLEMENT, No. 941, page 15034.]

## FLAME.*

By Prof. ARTHUR SMITHELLS.

KEEPING to our list, we ought next to deal with the combustible hydrogen sulphide or sulphureted hydrogen. This gas, you remember, is composed of two separately combustible elements, each burning in one stage. The flame is, as you might expect, two-coned, but I will not dwell upon this case—partly because it is not yet fully worked out, and partly because any prolonged experimenting with this gas would, I feel sure, be resented even by the most indulgent audience.

I am obliged, therefore, to pass to compounds of carbon and hydrogen, in which there are not only two combustible elements, but one of them, as we have seen, combustible in two chemical stages. Here we have an almost unlimited choice of materials, for we come among the combustibles which ordinarily supply us with light. I shall, for the sake of convenience, use coal gas. This is really a very complex combustible, consisting one half of hydrogen, the other half of at least a dozen different compounds of carbon and hydrogen. But experience has shown that the chemical phenomena attending its combustion are quite of the same character as those to be observed with a single compound of hydrogen and carbon.

It will, I imagine, be scarcely necessary for me to point out the various parts which are to be seen in the flame of a candle or of coal gas. There is on the diagram (Fig. 2, *c*) before you the picture of a somewhat small coal gas flame, produced at a circular orifice. It is, of course, enormously enlarged in the diagram. Four distinct parts are to be recognized. First, the central and darkest part; this contains the unburnt gas, just as we saw in the case of the carbon monoxide flame. Perhaps it is wrong to speak of this at all as part of the flame, for it is really a region of no flame. At the base of the flame are two blue strips embracing the lower portion of the flame. This appearance you will understand results from the mode in which we view the flame. The strips are really due to a sheath which goes right round the flame like an uninterrupted calyx. It looks bright where we view it edgewise. When we look through, as in the middle of the diagram, it is very pale indeed. Next we have to notice the bright yellow patch, so bright in the reality as to mask the other parts. Though it looks bright and dense, it is merely a hollow sheath. Lastly, there is surrounding the whole flame a pale mantle of flame of very slight luminosity, and of an almost indescribable tint, which perhaps we may call lilac. These parts are discernible in all ordinary flames. They do not always occupy the same relative space. In the flame given by a good gas burner the yellow part is made by intention as large as possible; in the flame of a piece of string or a spirit lamp you will see the outer investing mantle very distinctly developed.

If we are to understand flame, then, we must find an intelligible explanation of the existence of these distinct parts of its anatomy. One important point we can settle at once. An ordinary flame owes its differentiated structure to the slowness with which it gets the oxygen necessary for combustion. If there is an immediate and sufficient supply of air, the characteristic structure disappears. This we can secure by making the stream of gas sufficiently rapid. I have here a steel cylinder containing coal gas at very high pressure. If I allow the gas to escape slowly, we get a flame in which we should find the ordinary parts. But if now I allow the gas to issue rapidly, the admixture with air is so rapid. and, as you see, we have a pale flame quite undifferentiated in structure. We reach the same result by introducing a strong current of air into an ordinary flame, as in the blast blowpipe. The flame, you see, is then homogeneous, as in the previous case.

We see then that the structure of an ordinary gas flame is largely dependent upon the slowness with which the gas gets the air necessary for combustion. There is still one other evidence of this. It is obvious that a very small flame will have a much better chance of getting its oxygen quickly than a larger flame. It is, I am sure, within every one's knowledge that a very tiny gas flame is blue, and as a matter of fact, we can learn a great deal about flame structure by carefully watching the development of a very small flame. I am going to show you on the screen a series of photographs of actual flames. The photographs have been tinted as faithfully as possible.

The first slide (Fig. 3, *a*) shows a tiny gas flame burning at the end of a glass tube; it consists of a bright blue cone surrounded by a fainter one. Both are quite continuous. By putting in another slide, and using the "dissolving view" arrangement of the lantern, I will show you the effect of turning on the gas. The flame (Fig. 3, *b*) you see is larger, and now is observed a third region in the flame—namely, a patch of bright yellow at the tip. The original cones are still there, but are slightly interrupted at their apices. Turning on more gas, the flame (Fig. 3, *c*) again enlarges, the yellow patch increases in size, and the original cones are further broken into. But you see the yellow patch is indented at points corresponding to the inner cone, which, as it seems, is striving to maintain its integrity. Turning on still more gas, we have now a great preponderance of yellow, the original blue cone is reduced to mere vestiges, and the outer cone forms a faint surrounding to the whole flame (Fig. 3, *d*). This is flame as we ordinarily know it. I wish now to show you another series of changes. We must suppose the gas supply fixed, and the photographs I will show represent the changes which take place in the flame when air is gradually added beforehand to the coal gas. The supply of coal gas is, I repeat, the same in all cases. The first change seen is, you will notice, that the yellow patch diminishes in extent (Fig. 3, *e*). If I add more air, it diminishes still more, and the inner cone is growing in distinctness (Fig. 3, *f*). If I add a trifle more air, the yellow patch disappears altogether, and we have now complete and distinct inner and outer cones (Fig. 3, *g*). I think you will admit that these two sets of photographs show a close correspondence, and you can see it more plainly if I throw them on to the screen in a group. There is really nothing surprising in this similarity. The smallest gas flame has obviously the best chance of getting air, and when it gets enough, it burns in a two-coned flame. The same effect is reached by adding air to the gas before it is burned. If we have a larger gas flame it has, of course, less chance of getting its oxygen rapidly, and we see that in whatever way we starve the flame of oxygen, we lose the simple structure, and come upon the yellow patch.

Now, when we come to inquire into the chemical changes occurring in such a flame, we may, I think, feel confident that the chemical actions which determine the existence of the blue cone and the outer cone are the same, whether these cones are complete, as in a small flame, or fragmentary, as in a larger one.

If that is so, we can soon make progress, for, as I have shown you, we can easily separate these cones and find what is going on in each. I again use the cone-separating apparatus. First we have an ordinary luminous gas flame at the top of the outer tube. I pass in air, the flame loses luminosity, and rapidly becomes an ordinary two-coned Bunsen flame. I push the air supply further; the inner cone enters the tube, and descends until it rests on the end of the inner tube. The two cones of a hydrocarbon flame are thus widely separated; we can aspirate a sample of the gases, and see what changes have taken place in the first region

* An evening discourse to the British Association at the Nottingham meeting, September 15, 1893. From *Nature.*

of combustion. The result is one that we might await with curiosity, for we have now a competition. There are both carbon and hydrogen to burn, and not enough oxygen to burn both; the question is, which will have the preference? I think I may say that the offhand opinion of any chemist who has not had his attention drawn specially to this point would be that the hydrogen would easily have the preference. But, as a matter of fact, this question was settled long ago by Dalton, and in the opposite sense, and in the present case analysis would confirm this conclusion. If we analyzed the gases, we should find that all the carbon is burnt in the first cone, while a considerable part of the hydrogen passes through unburnt. The change is not quite so simple as these words might imply, as you will see from the actual figures of analysis.

ANALYSIS OF INTER-CONAL GASES FROM A COAL GAS AIR FLAME.

| | | | |
|---|---|---|---|
| Carbon monoxide | 8·7 | 17·9 combustible gases. | |
| Hydrogen | 9·2 | | |
| Carbon dioxide | 4·1 | 20·1 burnt gases. | |
| Water | 16·0 | | |
| Nitrogen | 62·0 | | |
| | 100·0 | | |
| Amount of air used | 78·5 | Oxygen | 16·5 |
| | | Nitrogen | 62·0 |
| Amount of air still needed | 42·9 | Oxygen. | 9·0 |
| | | Nitrogen | 33·9 |

About two-thirds of the carbon is burnt to form carbon monoxide, one-third to form carbon dioxide, while rather less than two-thirds of the hydrogen is burnt, and more than one-third remains altogether unburnt. We need not dwell on the details, especially as the analysis of the gases was made after they had cooled. The four gases—carbon monoxide, carbon dioxide, steam, and hydrogen—act upon one, as a matter of fact, while they are cooling down, and the distribution of the oxygen that we find in our analysis of the cold gas is not precisely that which exists in the gases as they just leave the inner cone. We shall only draw a general inference, and it is one that has been recently verified in a very complete manner by Prof. Dixon and his pupils. This inference is simply that the carbon in the inner cone is for the most part burnt to carbon monoxide, and that the hydrogen to a considerable extent is set free. So much then for the inner cone. The outer cone is due simply to the burning of the carbon monoxide and hydrogen which escape from the inner cone. When they meet with oxygen in the free air their combustion is completed. We are now in possession of the explanation of the two-coned gas air flame. Applying this to the tiny gas flame to which no air has been previously added, we see that the inner cone will be formed where the air has penetrated the gas sufficiently to produce such a gaseous mixture as we had in the lower cone of our separator. The gases coming from this burn further out when they meet with more air, and form a second cone.

The last thing we have to explain in the ordinary gas flame is the production of the yellow luminous patch, which, from the illuminating point of view, is the most important feature of all.

Now I need scarcely remind you that the general opinion is that this yellow patch in the flame is due to glowing carbon in a solid and very finely-divided state. The very familiar fact that a cold object introduced into the yellow part becomes coated with a black solid deposit, composed almost wholly of solid carbon, confirms this view. That this carbon or soot is solid in the flame is shown by the fact that it is deposited as a solid even when a highly-heated object is placed in the flame, and there are other proofs—some of them very pretty—which I cannot show for lack of time and of a means of magnifying.

This explanation is due to Davy, and constitutes his most celebrated discovery on the subject of flame. He describes it in the following words:

"When a wire gauze safe lamp is made to burn in a very explosive mixture of coal gas and air, the light is feeble and of a pale color, whereas the flame of a current of coal gas burnt in the atmosphere, as is well known by the phenomena of the gas lights, is extremely brilliant. . . . In reflecting on the circumstances of the two species of combustion, I was led to imagine that the cause of the superiority of the light of the stream of coal gas might be due to the decomposition of a part of the gas toward the interior of the flame where the air was in smallest quantity, and the deposition of solid charcoal which, first by its ignition, and afterward by its combustion, increased in a high degree the intensity of the light; and a few experiments soon convinced me that this was the true solution of the problem.

"I held a piece of wire gauze of about 900 apertures to the square inch over a stream of coal gas issuing from a small pipe, and inflamed the gas above the wire gauze which was almost in contact with the orifice of the pipe, when it burned with its usual bright light. On raising the wire gauze so as to cause the gas to be mixed with more air before it inflamed, the light became feebler, and at a certain distance the flame assumed the precise character of that of an explosive mixture burning within the lamp, but though the light was so feeble in this last case, the heat was greater than when the light was much more vivid, and a piece of wire of platinum held in this feeble blue flame became instantly white hot.

"On reversing the experiment by inflaming a stream of coal gas and passing a piece of wire gauze gradually from the summit of the flame to the orifice of the pipe, the result was still more instructive, for it was found that the apex of the flame intercepted by the wire gauze afforded no solid charcoal, but in passing it downward solid charcoal was given off in considerable quantities, and prevented from burning by the cooling agency of the wire gauze; and at the bottom of the flame, where the gas burnt blue in its immediate contact with the atmosphere, charcoal ceased to be deposited in visible quantities."

Only one attempt has been made to disturb the conclusion here drawn by Davy. In 1868 Prof. Edward Frankland, to whom we are indebted for many important discoveries respecting flame, came to the conclusion that the light-giving agency in flames was not solid carbon, but certain complex vaporous compounds of carbon and hydrogen. I regret very much that time will not admit of my detailing the evidence in favor of this view, or the counter evidence by means of which most chemists have been persuaded that Davy's explanation was, after all, the correct one. It is, however, right to remark that Prof. Frankland not only adheres to his own view, but promises to adduce further evidence in its favor.

Let us for the present, at any rate, stick to the opinion of the majority, and admit that the bright light of ordinary flames is due to incandescent particles of solid carbon. The next question is, How does this carbon become separated?

This question is dealt with by Davy, but in language of some ambiguity. He says, "I was led to imagine" . . . . that it "might be due to the decomposition of a part of the gas toward the interior of the flame where the air was in smallest quantity, and the deposition of solid charcoal which, first by its ignition and afterward by its combustion, increased in a high degree the intensity of the light."

Whatever these words may have been intended to mean, or whatever interpretation is the fair one, it is certain that Davy's explanation was soon presented as if it implied lack of air to be the chief cause of carbon separation. As there was a large quantity of hydrocarbon and only a small amount of oxygen in the central parts of flame, the hydrogen, it was said, being the more inflammable element, will seize upon this oxygen and leave the carbon uncombined. The fact that this version was given by Faraday lends some countenance to the belief that it was a fair representation of Davy's view.

Now this doctrine was really incompatible with facts known, though apparently not widely known, at the time. I have already referred to the fact that Dalton at the beginning of the century showed that when a hydrocarbon is exploded with a supply of oxygen insufficient to burn both the hydrogen and the carbon, it is the carbon, and not the hydrogen, which has the preference. If, therefore, we follow Davy in regarding flame as a tethered explosion, we cannot explain the separation of carbon as being due to the preferential combustion of the hydrogen. This fact was clearly pointed out by Kersten in 1861, but notwithstanding this, and other investigations tending to the same conclusion, the old view has somehow kept its ground down to the present day.

We must now turn to the alternative explanation, It is supplied by the words and, I think, by the intention of Davy. He says that the carbon separation might be due to the decomposition of the gas toward the interior of the flame. If this decomposition be not due to chemical action, it must be due to heat; and certain it is that hydrocarbons when strongly heated do decompose, and do deposit carbon. Here is a result of this action occurring on a large scale. This gas carbon, as it is called, is deposited in gas retorts owing to the action of intense heat on the hydrocarbons of the gas.

In another place Davy says: "I have shown in the paper referred to in the introduction, that the light of common flames depends almost entirely upon the deposition, ignition, and combustion of solid charcoal, but to produce this deposition from gaseous substances demands a high temperature."

This explanation of carbon separation in flames seems perfectly adequate and free from objection. There is, as we have seen, surrounding all ordinary hydrocarbon flames a shell of almost non-luminous combustion. The gas which passes upward within this shell must be highly heated, and in the absence of air will be decomposed so as to deposit solid carbon. This carbon is intensely heated, and glows, and as it reaches the air will burn to form carbon dioxide. The fact that the upper parts of flame are the most luminous in itself indicates that the more we roast the gas the more do we separate the carbon; and there are other proofs which I cannot stop to explain.

We have now got pretty well to the end of the explanation of the structure of ordinary luminous flames, and I will show you an experiment which epitomizes the explanations that have been given.

We turn once more to the cone-separating apparatus, and use as fuel a substance particularly rich in carbon. This substance, benzene, is a liquid; so I shall have to vaporize it by means of a current of air. When I apply a light to this current of air strongly impregnated with benzene, we get, as you see, a very bright flame. This flame exhibits the usual structure. This is one extreme. Now I will reduce the amount of benzene vapor very rapidly without altering the air, and we shall get the other extreme, that is, a scarcely luminous flame, consisting of one single cone. The whole of the combustion is now taking place in a single cone of flame. If I still further reduce the benzene, this flame enlarges slightly and becomes paler. There is now excess of air. A little less benzene still, and you see the flame rises from its perch and disappears; we have got past the limits within which combustion is possible. Let us next move in the other direction and gradually increase the supply of benzene to the single cone. It becomes smaller and brighter as we proceed up to a certain point. At length we have evidently got more benzene than there is air to burn, and now appears the second cone at the top of the tube. By sliding the tubes we can unite the flame and make a Bunsen flame. Separating the cones again, let us add still more benzene. The result is very remarkable. The two cones remain intact, but stretching between them are thin luminous streaks of glowing carbon. The excess of benzene is being decomposed by the heat, so that the carbon separates and glows. The more benzene I add, the broader do these streaks become, until eventually the inner cone ascends, the luminous streaks coalesce, and we have the ordinary luminous hydrocarbon flame.

I have now put before you the considerations and methods which will serve, I believe, for the elucidation of all problems of flame structure. I am not aware, at any rate, of any flame which does not accord with the general principles which I have explained to you.

There are many other flame problems besides that which relates to mere structure. Of these one of the most interesting concerns the coloration of flame. I will refer to it for a moment only to show how closely that question is connected with the points we have been discussing. I have here a gas flame to which I feed air until its yellow luminosity has disappeared. If I add to the air supply the fine spray of a dissolved copper salt, the flame assumes a green tint characteristic of the metal. This green tint seems to belong to the whole flame, but if we dissect it by the apparatus already so often used, we find that the green tint is developed only in the outer cone. It is due, in fact, to oxide of copper, which can only exist on the outside of the flame. Similar peculiarities are noticed with some other colored flames, and it is hoped that their study, which leads us into the domain of spectrum analysis, will yield some interesting information on points which are at present very obscure.

I have directed your attention this evening to terrestrial flames of small dimensions, but in conclusion I should like to remind you that at one time there were probably quite other flames upon this earth. The globe we inhabit is in the process of cooling and of oxidation; at one time we believe, in fact we know, that it was incandescent. If we take a chemical retrospect and imagine as we recede in time our present cool earth becoming hotter, we may follow out some interesting changes. We should soon reach a temperature too high for the persistence of liquid water; our oceans would be evaporated and surround the globe as an envelope of steam. In remoter times and at higher temperatures this steam could not exist even as steam, but

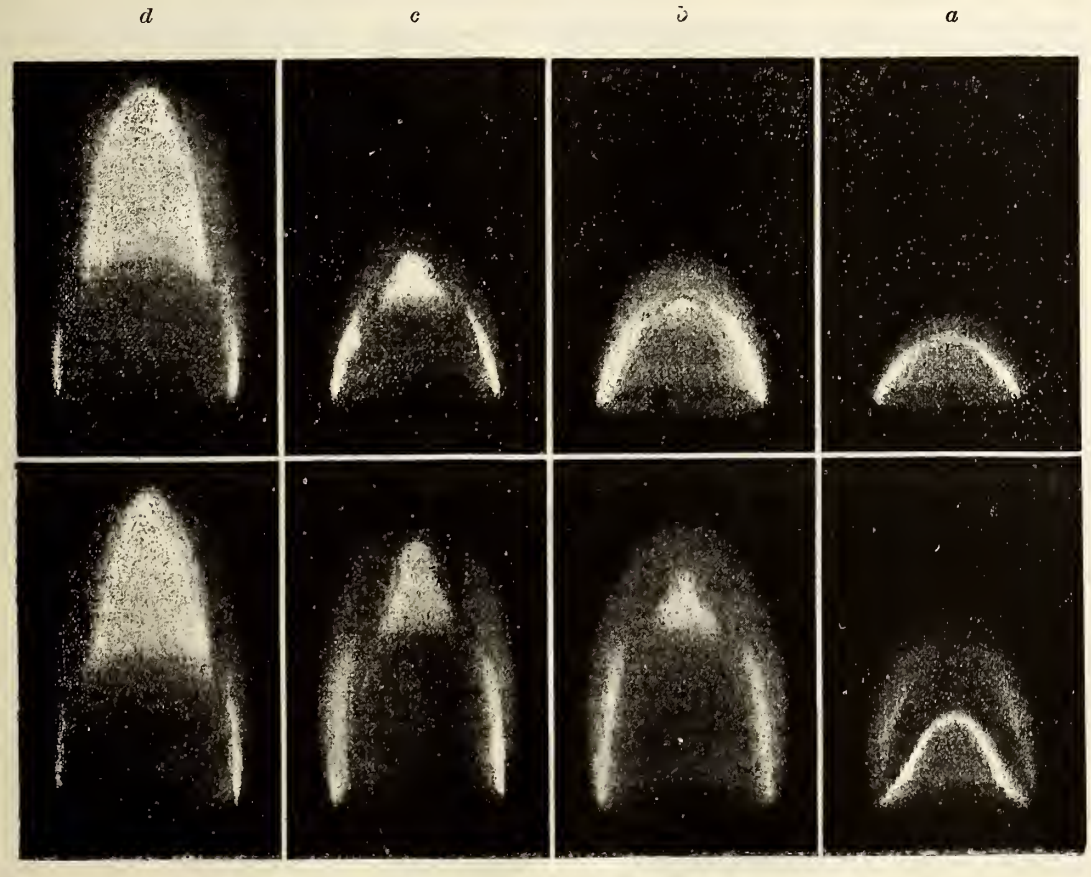



FIG. 3.—*a*, *b*, *c*, *d*, flames with successively increasing quantities of coal gas. *d*, *e*, *f*, *g*, flames with fixed supply of coal gas and successively increasing quantities of air.

THE EXPLOSION OF DYNAMITE IN THE CHAMBER OF DEPUTIES, PARIS, DECEMBER 9, 1893.—*From the Graphic, London.*

would be dissociated into hydrogen and oxygen. At that time, too, many of the elements now existing as oxides in the solid crust of the earth would be floating in a gaseous state in the vast atmosphere. Let us stop our retrospect at this point, and look toward the present with a cooling earth. At a certain point chemical combination must have begun in the fringe of the ancient atmosphere, and it must have been the scene of colossal chemical activities, the hydrogen and vaporous metals flashing into their oxides. On gravitating to hotter regions, these combinations may have been again undone, the elements sent again into circulation. How long such a period may have lasted we need scarcely stop to ask. If the retrospect is reasonable, it is enough. It is interesting to think how such an earth as we have pictured must have resembled the sun as we know it at the present day.

There was formerly a chemical theory of the sun, which ascribed both its heat and light to the act of chemical combination. That theory has long since been refuted and discarded, and with it ordinary laboratory chemistry banished from that luminary as altogether unsuited to its high temperature. There is cause, I think, to ask if this is quite warrantable. We know extremely little of chemistry at high temperatures, but if the sun could be shown to have its reasonable share of oxygen, we might well ask if its surface phenomena were not largely ascribable to ordinary chemical activities and of the nature of flames. It is certainly remarkable, when we consider the unity of plan in which heavenly b odies are seen more and more to move and have their being, that the sun should not exhibit the possession of its fair share of that element —oxygen—which has ruled the chemistry of the earth throughout all geological time and long precedent ages of its evolution. But this is ground which the terrestrial chemist must tread with care. He still has many unsolved problems lurking in the flame of a common candle, and flame, wherever we find it, is still a mystery.

"The power of fire or flame," says Carlyle, "which we designate by some trivial chemical name, thereby hiding from ourselves the essential character of wonder that dwells in it as in all things, was with the old northmen Loke, a most swift, subtile demon of the brood of the Jotuns. The savages of the Landrones Islands too (say some Spanish voyagers) thought fire, which they never had seen before, was a devil or god, that bit you sharply when you touched it, and that lived upon dry wood. From us, too," adds Carlyle, "no chemistry, if it had not stupidity to help it, would hide that flame is a wonder."

## THE DYNAMITE EXPLOSION IN THE CHAMBER OF DEPUTIES, PARIS.

ANOTHER link in the chain of Anarchist outrages was forged December 9 last by the bomb explosion in the Paris Chamber of Deputies. Certainly, the Anarchists' scheme of vengeance is sufficiently comprehensive. In less than three months they have struck at a popular general and an aristocratic theater audience in Spain, at an Emperor and his Chancellor in Germany and now at the representatives of the sovereign people in France. But this last attempt has raised a storm of alarm and indignation which is likely to limit the Anarchist sphere of work very considerably. Hitherto, in France, at least, the police supervision has been distinctly lax. Otherwise such a well known bad character as Vaillant, the author of the crime, would not have been allowed to enter the Paris Chamber. According to the terms of the French constitution, the debates of the Lower House must be public, and a top gallery is reserved for the use of the general public without admission tickets. Very often, in winter, regular loafers come in for the sake of warmth and bring food with them, so that the entrance of a shabby man and a parcel would pass unnoticed. On December 9 the House was quietly discussing a contested election, when suddenly a red light shone in the air, a noise like pistol shots was heard and white smoke filled the building as a rain of nails fell around. A bomb had been thrown from the upper or public gallery. Happily, it had burst before reaching the floor, thus lessening the force of the explosion; but the results were bad enough. Deputies were stunned and bleeding, people in the galleries were groaning with pain and fright and for a few seconds panic prevailed. Then the House recovered itself. the injured were helped away and M. Dupuy, the President of the Chamber—who was himself slightly hurt—begged that the debate should continue. His coolness was infectious, and the work in hand was duly finished before the Premier said a few words promising firm government action and the sitting was closed. Outside the Chamber the officials had the good sense to shut the doors and keep prisoners all but a few of the public who escaped in the first confusion. The wounded were quickly attended to in the House itself, over fifty persons being injured, the majority slightly. The worst cases were those of the Abbe Lemise, hit on the back of the neck; an usher, M. Schillinger, the top of whose skull was blown off, and a spectator, who was obliged to undergo trepanning. All the sufferers are doing well. A cordon of troops had surrounded the building, and as the people were recognized as harmless they were let out, the police keeping back several suspicious individuals, including a man who called himself Marchal and was wounded in the face. After a short investigation this man confessed to the crime, and, with the customary bravado of his brethren, told how the bomb was thrown. The criminal threw it in such a manner as to appear that the bomb came from the next division of the gallery, but owing to a woman touching his arm his aim deviated, and the bomb struck a pillar and exploded prematurely.

This so-called Marchal proves to be a notorious Anarchist named Vaillant, who had borrowed a comrade's name to avoid detection. He has been in prison repeatedly since the age of sixteen and is well known to the police.

After the first shock of horror, Paris took the matter very coolly, reassured by the decision of the government to strike at the very root of the trouble. No time was lost, for M. Casimir-Perier appeared at the next sitting of the House with four strong repressive measures. These were a modification of the Press Bill of 1881, providing that incitement to robbery, murder, pillage and arson shall be punished by imprisonment; an alteration of the penal code relating to associations of malefactors; a modification of the law on explosives and the opening of an extra police credit. The first of these measures was particularly obnoxious to the Extreme Radicals as limiting the liberty of the press. But the House was so thoroughly roused that all the opposition of M. Goblet and his friends went for naught, and the government carried the day by 413 votes to 63. This enables the government to put down certain firebrand journals, which stir up the lowest class of the population to discontent and revolution. Stringent regulations for admittance to the Chamber have also been made, and no precaution is being omitted at the various public buildings. So far the outrage has decidedly turned the scale in favor of the present Ministry, for the Socialists, who were so strong a power in the new House, dare not raise their heads lest they should be confounded with the Anarchist party. There is a general feeling in France that international action should now be taken against the Anarchists, and most other countries share the opinion. No nation, however, cares to take the initiative, and her neighbors warmly urge France to lead the way. The utmost sympathy has been shown to France on all sides, nearly every parliament sending a message of congratulation to the Chamber. Russia is especially sympathetic, as she is just hearing of another conspiracy to assassinate the Czar.

When Vaillant was subjected to the examination in the hospital where he had been sent for the dressing of his wounds, he readily furnished a detailed description of the bomb. "It was," he explained, "a small iron saucepan which I bought at the bazar of the Hotel de Ville a few days ago. It was filled with nails, and among them was a tube compressed in the middle. In this tube there were two substances—picric acid and prussiate of soda, these being separated at the point where the tube was compressed by a small ball of cotton saturated with sulphuric acid. The sulphuric acid would, in a given time, eat away the cotton, and the other substances would then unite and produce an explosion."—*The Graphic, London.*

ELECTION RIOT IN GREECE—THE FIRE DEPARTMENT DISPERSES THE MOB.

## A NEW USE FOR STEAM FIRE ENGINES.

THE recent elections in Greece were attended with grave disorders in several places, amounting in some instances to riots and personal violence. In the city of Athens party spirit ran so high that the governor deemed it necessary to make a rule there should be no gatherings in the public streets after nine o'clock at night. On one occasion a large public meeting was held in one of the principal squares, the orator of the occasion being the editor of one of the prominent newspapers. The proceedings were opened at 8.30 in the evening, and when the hour of 9 was sounded by the great clock in the Plaza, the editor had not finished his speech and declined to stop, as the governor required. This refusal brought on the prospect of a riot; whereupon the governor ordered out the steam fire engines in the vicinity, and the firemen drenched the talkative orator, suppressed his eloquence in the most effective manner and wet down the crowd, which dispersed, the people running to their homes to escape the unexpected deluge.

Our engraving is from *La Ilustracion Española.*

## THE DEADLY AND MINOR POISONS OF TOADSTOOLS.*

By CHARLES MCILVAINE, M.D.

I USE the word toadstool as covering visible fungi and as distinguishing certain forms of fungoid growth from the microscopic. While many of the miscroscopic fungi number their human victims by the thousands, and are further reaching than co-conspirators of the visble sorts, their efforts are better understood by the medical profession than those belonging to the higher orders of which I shall exclusively write.

To Mr. Julius A. Palmer, of Boston, is due the segregation of the amanita—the aristocrats of the fungoid world—as the only mortal toadstool foe of man. To Dr. J. E. Shadle, of Shenandoah, Pa., must be given credit for describing the actual contact in the human system of atropine with the amanita poison.

The writer was fortunately enabled by these cases of Dr. Shadle to name the toadstools putting in their deadly work, and for the first time positively naming their foil face to face with them to the medical profession (see *Medical and Surgical Reporter*, "Amanitine and its Antidote," McIlvaine, December 12 and 19, 1885).

While atropine had been designated by such a writer as Dr. Gautier, Paris,* as a probable, certainly a theoretic, antidote for toadstool poisoning, it had never before been called upon to sustain its prognosticated reputation. Here is the best place to say that poisoning by amanitine must be met heroically by the subcutaneous injection of atropine, beginning with $\frac{1}{60}$ grain, and continuing until $\frac{1}{20}$ grain is administered; more, if necessary to save life.

It is unfortunate that the authorized dispensatories and pharmacopœias have settled upon muscarine as the name for this powerful alkaloid. The *Agaricus muscarius* is a member of the family of amanita. Its alkaloid is the base of the well known fly poison. Bulbosine, muscarine, are but family derivatives. All possess the qualities, and should bear the family name—amanita, amanitine.

Among peoples but little attention would be drawn to the amanita family, did it not so closely resemble the members of the common mushroom clique. To those familiar with both families there is not even a cousinly resemblance; but to those who believe themselves positive in their knowledge of "the only mushrooms fit to eat" there is a dangerous nearness.

In this paradoxical resemblance lies the prominence given to the amanita family, because of its seductive beauty and the fatal mistakes made in eating of its members.

All of the amanita have distinguishing marks. They wear royal robes of certain cut. They are all umbrella shaped. They all spring from a volva. Fragments of this ruptured sheath are frequently found upon the upper surface of the spread cap. About the base of the stem—generally bulbous—stays the principal part of the envelope from which they have burst. Up the stem, near the top and just under the white gills, is a ring surrounding it. Sometimes this hangs as a plaited skirt about the stem. Sometimes it is merely indicated by a yellow stain.

All of the amanita, being white spored, have white gills. The common mushroom, being purple spored, has pinkish gills in youth, which increase in depth of color as the spores ripen to a heavy purplish black. The amanita are choice in their habitat. They live in wooded depths or on the margin of timber lands. I have never found them in open fields and meadows. On the other hand, the common mushroom is never found in woods. It lives in the open. If these distinctions of growth and habitat could be impressed upon the public, there would be no more cases of amanitine poisoning.

The physician called upon to treat a case of toadstool poisoning, need not wait to query after the variety eaten; he need not wish to see a sample. His first endeavor should be to ascertain the exact *time* elapsing between the eating of the toadstool and the first feeling of discomfort. If this time is within four or five hours, one of the minor poisons is at work, and rapid relief will be given by the administration of an emetic, followed by one or two moderate doses of sweet oil and whisky in equal parts. Vinegar is effective as a substitute for oil. If from eight to twelve hours have elapsed, the physician may rest assured that amanitine is present, and should administer $\frac{1}{60}$ grain of atropine at once.

No stomachic troubles follow immediately the eating

* Abstract from the *Therapeutic Gazette.*

* "Les Champignons," Paris, 1884.

of the poisonous amanita. Digestion occurs without complaint.

It is possible that indigestible or mildly poisonous toadstoods may have been partaken along with the amanita. In this case the time and symptoms would indicate the fact, and they should be eliminated from the system by the means mentioned. The patient should then be watched for the appearance of changes due to the more virulent poison.

One of the first symptoms is a peculiar ashy pallor of the complexion.

In relation to the latter, Mr. Palmer writes:

"The absorption of the poison from the amanita may take place not only by ingestion, but by contact with the skin, as through the hollow palm of the hand or arm; by the lungs, as I have proven by personal experiments made upon myself. In such a case the patient has all of the symptoms of having eaten of the mushrooms, *even to a peculiar leaden or ash-colored complexion.*"

Many of the amanita are not only nutritious, but delicious. Of the nearly forty varieties, not over eight are known to be deadly.

In testing, by carefully eating of over four hundred varieties of toadstools, for their edible and non-edible qualities, by smelling, by absorption of the juice while dissecting, I have frequently felt and seen on my own face symptoms of amanitine poisoning. My experiments upon dogs show that injections of minute quantities of an infusion in water or alcohol of any one of the poisonous amanita is fatal in from twelve to twenty hours, but that the fatal effects may be arrested at any but the final stage by varied doses of atropine. Similar results will obtain by the use of amanitine as an antidote for atropine. The difficulty I have encountered is in the separation of the alkaloid and obtaining solutions of known strength.

It should be borne in mind that the exhalations of those poisoned by amanitine are highly poisonous, and the urine as deadly up to the tenth or twelfth dilution, by passage through the human system, as the original poison itself.

Dr. Edward Jacob Forster, Boston, Mass, in an excellent monograph, entitled "Mushrooms and Mushroom Poisoning," read before the annual meeting of the Massachusetts Medical Society, June 11, 1890, says, "The treatment by atropine is based upon a perfect antagonism which exists between this drug and the poison of the amanitas, which has been separated by Professor Schmiedelberg, and named muscarine. The poison has been separated by others and variously named, according to the variety from which it was obtained. The merest trace of this alkaloid will arrest the pulsation of a frog's heart, and even after four hours Lauder Brunton states he has caused it to pulsate again by a minute quantity of atropine being brought in contact with the organ. This and other experiments showing the antagonism between these two poisons have been repeated by Professor H. P. Bowditch at the Harvard Medical School. It acts as well upon mammals as upon frogs."

[We understand Dr. McIlvaine has lately written a book, "Our Friends and Foes Among the Toadstools," which will soon appear.—ED. S. A.]

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[FROM KNOWLEDGE.]

## CURIOUS COCOONS.

By E. A. BUTLER.

THOSE insects which, just before assuming their final form, pass into a limbless, inactive condition, or, in other words, become a chrysalis and undergo a complete metamorphosis, evidently need some special protection during this period of rest, when they are unable to look after their own interests. And the need is intensified by the fact that the period of pupahood often lasts throughout the winter, so that the insect spends a larger proportion of its life in this helpless and passive state than in a condition of activity. The means adopted to meet the need are varied, but the majority of cases may be grouped under two heads: either the insect buries itself in the ground or, remaining above ground, envelops itself in a silken covering or cocoon. While the former method, from the nature of the case, presents few peculiarities and calls for little remark, the latter is full of interest in consequence of the variety of form and the remarkable adaptations and contrivances which the cocoons exhibit; we therefore propose briefly to discuss the most interesting of these specimens of insect architecture which are to be met with in the woods, fields and hedges of our own country. We naturally look to the Lepidoptera for our chief, though not for our only, examples; the most notably cocoon constructing section of this order is the group called Bombyces, including the moths known in popular phraseology as "tigers," "ermines," "eggers" and "emperors."

But before referring to specific instances in detail, a few words are necessary as to the organ by which the material used in these constructions is produced. There is a pair of glands which are found only in the larvæ, and disappear in the adult insect, and in these the silk is secreted as a gummy substance. They are bent and coiled tubes, lying at the sides of the body, and they sometimes extend for a considerable distance from the head toward the tail. Their structure is similar to that of salivary glands, but they do not communicate with the mouth, and consequently the silk does not, as at first sight it appears to do, issue from the mouth. The ducts from the glands unite into a common canal, which opens upon a minute papilla a little below the mouth, and from this the secretion exudes. Though glutinous at first, it has the property of drying and hardening as soon as exposed to the air, thus losing its stickiness. In this, as well as in other respects, it differs from the silk of spiders, which is secreted by glands at the opposite end of the body, and which, as serving the purpose of a snare, remains more or less sticky after exposure.

The cocoons of different species vary in color from white, through shades of yellow, brown and gray, to almost black; but this is probably not entirely due to differences in the natural tint of the silk, but to processes it undergoes after having been spun, or to the admixture of foreign matter. The larva always forms its cocoon round itself, so that it is usually an entirely closed covering, with no indication of a way of entrance or exit. As it is most commonly constructed among twigs, dead leaves, etc., or in crevices and corners and under ledges, a few threads are first run promiscuously among surrounding objects to serve as a sort of scaffolding or mooring, and then a much more compact structure is fashioned in the center of these, so as closely to envelop the body of the spinner.

It is difficult to say what have been the influences that have determined the shape of the cocoon in each species; certainly neither the shape of the caterpillar nor that of the chrysalis is the factor of prime influence, since we find that caterpillars of similar shape make very different cocoons, while there are caterpillars of very dissimilar appearance which make cocoons more or less alike; and there seems no particular reason why a shape that suits one would not equally well suit another. Moreover, it sometimes happens, as with the emperor moth to be presently described, that the small end of the chrysalis lies in the big end of the cocoon, so that no attempt is made to secure what tailors would call a "good fit." The protection afforded by the inclosure of the pupa in a cocoon is not necessarily entirely in the direction of the disappointment of insectivorous enemies—in fact, as to the extent to which this sort of protection may be necessary there is great lack of definite information, and whatever opinion may be formed will be more or less conjectural; we are not in a position to say exactly, from actual observation or experiment, what insectivorous animals would be glad to feed upon these pupæ, but are balked in their desire by the presence of the cocoon. Besides this somewhat hypothetical advantage, however, there are the obvious benefits of the degree of fixity the cocoon gives to a body which, if lying free and loose on the ground, would be at the mercy of any disturbance in its surroundings and of the shelter afforded by inclosure in a non-conducting and probably damp proof medium amid changing climatic conditions, especially when its use is required during the winter season. But there is abundant scope for inquiry in all these directions, and if any of our readers feel inclined to investigate the subject for themselves, they will doubtless be rewarded with discoveries.

Among the numerous cocoons formed by British insects none is more remarkable than that of the emperor moth (*Saturnia carpini*) (Fig. 1). As a rule, cocoons are more or less oval in outline and of similar shape at each end, but in the present instance we have a pear-shaped or flask-shaped body, rounded and swollen at one end and with a large circular opening at the other. A little distance below the opening a set of stout threads, almost like bristles, pass from the inner wall of the cocoon all round in an upward direction toward the center of the opening, where they meet, thus closing the cocoon by a hollow, conical, brush-like partition, which effectually bars entrance from without, but admits of easy egress from within by merely pushing the threads on one side. Thus, by this very simple but exquisite contrivance, no obstacle is placed in the way of the exit of the moth when matured, although the precious contents of the chamber are during the long continuance of pupahood securely shut off from any would-be robber in the outer world.

FIG. 1.—Cocoon of Emperor Moth, part of outer wall being removed at the top to show conical barrier of fibers.

The color of these cocoons is variable; usually they are some shade of deep brown, but sometimes they become of a pale creamy white. It has been supposed by some naturalists that this difference is intentional, and that its object is to enable the cocoon to harmonize more completely with its surroundings, and so more effectually to elude notice. Many careful experiments have been made to determine this point, since if established it would be a more remarkable physiological fact than the change of color in the surface layers of a caterpillar's skin, under the influence of external colors, to which we alluded some time ago. For we are not here dealing with a case of concealment brought about by the attachment of foreign objects of suitable color selected from the surroundings, a case which would imply no more than a certain degree of intelligence and ingenuity on the part of the fabricator of the cocoon; nor is it an instance of the color of the caterpillar itself being so modified as to correspond more closely to its surroundings; but it would be an instance of a living being retaining its own color unchanged, but possessing the power of modifying the color of its deep-seated secretions at will, or at any rate in response to external optical stimulus merely, notwithstanding that usually the act of secretion is one of the most unconscious and involuntary which take place in the life of an organism. The experiments did not lend much support to the hypothesis of protective coloration, but pointed strongly toward a different reason for the presence or absence of the dark brown color.

By first inclosing single caterpillars which were about to spin in pockets made of various materials, some dark, others light, and, secondly, inclosing families of caterpillars in white and black muslin bags, abundantly supplied within with crumpled pieces of white and brown paper respectively, so as to make the surroundings as uniformly light or dark as possible, Mr. W. Bateson has shown that the color of the cocoon is independent of that of the material on which it is built, for dark cocoons were attached both to dark and light substances indifferently, and *vice versa*. But it was observed that the more natural were the surroundings of the caterpillar, and the less it was interfered with at the close of its larval career, the greater was the tendency to form a dark cocoon, the light ones being made specially by those which had been removed from their food plant. Continued association with the food plant up to the time of transformation thus seemed necessary for the construction of cocoons of full color. It was further observed that the caterpillars had the power of ejecting from the mouth a green liquid, which, apparently, by a process of oxidation, became brown on exposure to the air; and that, in all probability, a similar fluid was voided from the hinder extremity of the alimentary canal. There were many indications, which we have not space here to detail, that it was this fluid, derived from the partially digested food and ejected from the alimentary canal, which stained the cocoons and gave them their brown color, and that when light cocoons were made, the caterpillars had probably already voided this fluid before their isolation, and therefore possessed no further store to stain the cocoon as soon as it should be made; or, by being removed too early from their food, failed to make the fluid, and were therefore unable to give the cocoon the usual layer of coloring. Thus the color of the cocoon would seem to be dependent, not upon the predominant tint of the surroundings, but upon the condition of the caterpillar at the time it is made.

Of course it still remains an open question why this liquid should be poured out upon the cocoon at all, and in what way it may conduce to the well-being of the insect that its abode during its time of quiescence should be thus varnished. The coloring substance, though soluble in water at first, becomes incapable of being washed out when once the cocoon is stained, thus proving itself a fast color. It is an obvious suggestion that this dyeing of the cocoon may have something to do with rendering it impervious to the rains of winter; but it is hardly safe to hazard such a conjecture, since other equally plausible suppositions might no doubt be made, which yet experiment might show to be untenable; it is better, therefore, to wait for the results of further experiments before coming to any definite conclusion.

It should be remarked that there seems no particular need of further protection to the chrysalis than that which it already possesses in being inclosed within the very tough skin of the cocoon. Any insectivorous animals which might otherwise feel disposed to prey upon it would apparently be sufficiently kept at bay by this very unmanageable material, so that special efforts for the concealment of the besieged after the acquisition of so excellent a breastwork would seem to be only wasted energy.

The egger moths are so called because of the very compact, egg-like cocoons they make. The two species best known in this country are the oak egger, a fine large yellowish brown moth, which appears in summer time, and the small egger, a much smaller species of a reddish brown color tinged with ashy gray, which makes its *debut* in midwinter. The cocoons of both of these are very similar—parallel sided, and equally rounded at each end (Fig. 2). The silk is close and

FIG. 2.—Cocoon of Oak Egger Moth.

compact, and forms a parchment-like shell, thin but hard, and extremely smooth within; in each case it is an exceedingly close-fitting cell, which is not more than half the length of the caterpillar that makes it; hence it follows that, as the artificer is accommodated within during the whole of the time of construction, it finds itself very cramped for room as it turns about and carries its thread from side to side. The small egger, in some unaccountable way, always leaves a minute perforation in one side of its cocoon, an arrangement which its larger relative does not imitate. From this hard and compact shell the moth makes its escape by pushing off from one end an irregular piece, which looks as if it had been bitten round. When we remember, however, that the moth is entirely destitute of biting jaws of any kind, the real method of escape is seen to be a great puzzle, for the separation of this portion of the cocoon clearly implies the severance round its edges of the crossing and recrossing threads of which the cocoon is composed, and it is difficult to understand how that should be done without a biting or cutting instrument. Careful watching of the emerging moth is here of little use, for the cocoon is opaque, and the attack is made from within, and when we catch the first glimpse of the head of the newly-fledged insect issuing from the cocoon the deed is already done, and the escaping prisoner has kept its secret as effectually as Messrs. Maskelyne and Cooke in their escape from within their closely corded box.

The problem has, however, recently been somewhat satisfactorily attacked in the case of a different insect, and one imprisoned, it might be imagined, more entirely beyond hope of escape than either of the above. The moth in question is the puss moth (*Dicranura vinula*), of whose extraordinary caterpillar we gave our readers a description some time ago (*Knowledge*, February, 1893).

This creature selects a crevice in the bark of a tree, and excavating it into an oval hollow, roofs itself over on a level with the surrounding bark, with a layer of mixed silk and chewed bark, which closely imitates the color and roughness of the true bark, so that often nothing less than the closest and most minute scrutiny avails for the discovery of the cocoon. This roof of mingled silk and sawdust does not reveal distinct threads, as has been the case with the other cocoons, but seems to be composed of one continuous mass; it becomes so hard and unyielding that the blade of a knife, unless very firmly pressed, slides off and makes no impression on it. This intensely hard roof completely covers in the dumpy brown chrysalis into which the brilliant caterpillar changes, and from this at the end of the following spring issues the large fluffy soft-

bodied moth, with its whitish wings prettily penciled with gray streaks, in a manner which recalls the markings of a tabby cat. In this case, as before, a portion of the hard shell is burst off just above the anterior end of the chrysalis, making a hole just large enough for the moth to squeeze itself out. Thus the problem is repeated, and with an added intensity. How can a soft-bodied creature, with no jaws or claws, work its way through a partition almost as hard as if it had been made of metal?

For the solution of the problem the analytical chemist had to be appealed to, for the moth, not having sufficiently strong mechanical means to free itself from its prison, invokes the aid of chemistry. Mr. Oswald Latter removed some pupæ from their cocoons shortly before their emergence, and wrapped each up in a piece of the thin blotting paper used by chemists for filtering solutions. Each, therefore, on becoming a moth, had to pierce the paper instead of its cocoon. As this took place it was found that the paper was wetted at the spot of emergence, a stain being left behind when it dried. By using a number of these stained papers, enough of the material which composed the stains was procured to enable an analysis to be made. It was then found that the liquid, which was evidently poured out by the moth at the time of its emergence, was none other than that very well-known substance, caustic potash, renowned and widely used for its solvent powers. This was a very interesting discovery, for it had not previously been known that any animal secreted a caustic alkali; moreover, it was doubly interesting from the fact, to which we have previously referred, that the caterpillar of the same moth secretes a liquid of a chemically opposite character, viz., formic acid. The next step was to try whether the material of the cocoons was soluble in caustic potash. A few drops were placed on the inside of some cocoons, and in three minutes they were reduced to a pulp. Here, then, stood revealed the means by which the creature was able to effect a breach in its strong prison walls; it actually dissolved its way out by means of a caustic alkali.

But the explanation was not yet quite complete, for if the alkali were the only means of egress used, it seemed likely that there would result a general softening of a part of the wall of the cocoon, and a bursting out through that, rather than, as was really the case, the neat separation of a portion of the wall, the severed piece remaining as hard as the rest. The moth was found to make its exit wearing a sort of cap, consisting of the front part of the chrysalis shell, which fitted on to its head by means of little projections and sockets and served as a shield protecting the underlying parts from damage during the passage out. Close examination revealed just beneath this shield a couple of hard sharp points projecting from above the moth's mouth, and usually concealed by the fluffy down around. These are the instruments by which the section is made, though they would be quite powerless if the silk were not first moistened and softened by the secretion. Thus the moth is most wonderfully armed for burrowing its way out; with a shield on its head, two diggers beneath, and a supply of alkali to overcome the resistance of the wall it has to penetrate.

When cocoons are attached to grass stems, they naturally tend to become shuttle-shaped; the stem runs up one side, and the ends of the cocoon taper away till they are reduced to the thickness of their support. Two very good instances of this are to be seen in the "drinker" moth and the family of burnet moths. The caterpillar of the "drinker" (*Odonestis potatoria*) is a hairy creature with two extra long and close tufts of black hairs like horns, one at each end, and also with a number of short snow white and deep yellow or orange tufts along the sides. It feeds on grasses, and has the habit, when disturbed, of dropping to the ground and rolling into a very compact ring. The moth is colored something like the oak egger, but it is not so large; nevertheless, the cocoon (Fig. 3) is a good deal larger. It is of a pale yel-

FIG. 3.—Cocoon of Drinker Moth, on grass stem.

lowish color, leathery and flexible, and thus quite unlike those we have just been considering. It has a slightly irregular and crumpled appearance outside, but inside is smoother, although the individual silken threads can be much more distinctly traced here than outside, where the texture looks more irregular and matted. Some of the caterpillar's hairs are worked into the structure outside.

The burnet moths are extremely brilliant insects, which frequent grassy hillsides and meadows, and delight to fly in the brightest sunshine. There are several kinds, but they are all narrow winged moths, with long stout bodies; the forewings are of a brilliant metallic greenish black, adorned with crimson spots, and the hind wings are rich crimson with a black border. The commonest species (*Zygæna filipendulæ*) has *six* crimson spots on the forewings, and is an abundant and well known insect in suitable localities. The cocoons of these creatures are of a shining golden color, thin and papery in consistence, but nevertheless harder and more unyielding than that of the "drinker," as well as much smaller. They are usually attached to grass stems, and three or four are sometimes placed on the same stem (Fig. 4), either one above the other or clustering round at the same level, and, therefore, more or less overlapping one another. Their bright color and elevated position makes them very conspicuous objects. Occasionally the cocoons are constructed in other places, such as on fern fronds, thistle stems, or even stones, but the

FIG. 4.—Four cocoons of Burnet Moth, on grass stem, the empty chrysalis cases projecting.

grass stem is the general rule—a rather curious association, since grass is not, as it is with the "drinker," the food plant.

There is no difficulty in telling whether the insect is within or not, for when it escapes it leaves the front half of the empty chrysalis case sticking out of a hole in the cocoon, and the contrast between the black shell and the golden vase which supports it is very striking. This position is assumed by the chrysalis before the emergence of the moth, whence it is evident that, though limbless, it has the power of climbing; the means of doing this consist of rows of minute hooks on the segments of the abdomen, just as with the leaf-rollers we described on a former occasion. In this habit the burnets are quite unlike the other insects we have referred to, which, as they have no hooks and cannot climb, all leave their empty shells wholly inside the cocoons. Another difference is that the cocoon is simply burst open at the end, and no part of it is actually separated from the rest. But here again we find a resemblance to the "drinker," which does the same; and since in this case the chrysalis skin does not project, and the cocoon is scarcely damaged by the escaping moth, it is not an easy matter except by the touch, to decide whether the cocoon is empty or full. Neither "drinker" nor burnets require the accommodation of the cocoon for more than a few weeks at the outside, and when once they are broken open and deserted, the weather soon makes them more and more dilapidated, and they are not long in going to ruin.

When once a moth has escaped from its cocoon there is generally no further use for the deserted shelter, and it is left to take its chance of wind and weather. But in one or two instances, at least, this rule does not hold good, and the vacated cocoon still serves a useful purpose in the economy of the insect. The vaporer moth (*Orgyia antiqua*), whose curiously tufted and tussocked caterpillar we alluded to on a former occasion, employs its old cocoon as a receptacle, or rather support, for its eggs. In every part of its economy this insect is an odd creature. It is one of those few Lepidoptera the females of which are practically wingless. The male insect is a lover of bright sunshine, and flies in search of its apterous and stay-at-home mate during the hottest parts of summer days. As it is an exceedingly common insect, and the caterpillar feeds upon a variety of shrubs which are among those cultivated by man, it makes itself quite at home in the gardens and squares of our large towns, and may often be observed gayly fluttering along the streets in the neighborhood of its home. It is a modest little broad-winged, russet-colored insect, with a crescent-shaped spot of white toward the outer and lower corner of each forewing and with beautiful comb-like antennæ. Its partner does not rely upon beauty as a recommendation, for she is one of the plainest-looking creatures imaginable, and it requires a stretch of charity to refrain from calling her positively ugly. She possesses the merest rudiments of wings, though, as she never uses them, she might as well have none at all. Her figure exhibits an excess of obesity which, to the human eye at least, is sufficiently repulsive, but apparently it has its attractions for her own kind, for the males will come long distances for the honor of becoming the possessors of her unwieldy frame. Her body is clothed with a thick covering of pale, grayish hairs. She never leaves the cocoon which was the home of her pupahood, but waits upon it till the arrival of her accepted swain, after which she lays her eggs, scattering them over the surface of the cocoon, the greater part of which they are generally numerous enough to cover. This done, she dies.

The cocoon is loosely constructed; the silk is fine and glossy, but as many of the caterpillar's hairs are intermingled with it, the texture appears coarse and irregular, and the black, brush-like hairs that belonged to the tufts at the sides of the neck and at the tail are sometimes conspicuous objects among the otherwise pale yellowish mass (Fig. 5). The cocoon is not a complete one, like most of those described in our last paper, but should rather be described as simply a web forming a roof arching over the chrysalis, the surface of a tree trunk or wall constituting the base of support and occupying the whole of the other side. The chrysalis is of a deep brown color, and, strange to say, is ornamented with tufts of hairs on its different segments, a feature which is, however, characteristic of the family. The scattering of the eggs over the web may, perhaps, in some way be connected with the unusual circumstance that the eggs do not all hatch at the same time, but the young caterpillars continue to issue from them during a period of ten weeks, so that eggs, caterpillars, pupæ and perfect insects may all be

FIG. 5.—Part of cocoon of Vapourer Moth, showing one of the black brush-like hairs. Magnified six diameters.

met with at the same time during the summer. Another species, called the scarce vaporer moth (*Orgyia gonostigma*), a much less common insect, has similar habits.

It may be taken for granted that hairy caterpillars will, as a rule, intermix their hairs with their silk, thereby effecting a considerable saving of material; but this is not very different from saying that cocoons may generally be expected to contain hairs, for it is chiefly, though not exclusively, hairy caterpillars that make cocoons, and the longer and more numerous the hairs with which the caterpillar is clothed, the larger will be the proportion they will bear to the silk in the construction of the cocoon. This is very manifest in the slight web formed by the garden tiger moth (*Arctia Caja*), whose caterpillar, popularly known as the "woolly bear," is the hairiest of a hairy family. The web is thin, and the dark hairs are extremely conspicuous. This is also true of the rest of the "tigers," belonging to the same genus, and of the "ermines," belonging to the genus *Spilosoma*, and the color of the cocoon is, therefore, obviously determined largely by that of the caterpillar's hairs. Now, it is clear that if an attempt were made to utilize the silk of such cocoons, the numerous hairs scattered among and clinging to the threads would become a serious inconvenience in the unwinding of the silk, even should the threads of the latter be sufficiently continuous to make such a procedure possible. It is fortunate, therefore, that the silk worm of commerce is not a hairy insect, for if it were it woul assuredly mingled its hairs with its silk and thus render its cocoon useless for manufacturing purposes. The fact that it is hairy when first hatched, though it loses its hairs almost entirely at the first moult, seems to point either to an original adult hairiness when in a wild condition, or at least to its descent from hairy ancestors. As the present excellence of the silk is, no doubt, due to long domestication and careful selection, it is quite possible that a reversion to hairiness of body in the adult condition would be accompanied by a deterioration in the quality of the silk itself, quite apart from what would result from the admixture of hairs.

Among other curious lepidopterous cocoons may be mentioned that of the lackey moth (*Clisiocampa neustria*), yellowish white, and supplied when first formed with abundance of pale yellow powder like flowers of sulphur; this is at first scattered through the silk, but gradually collects in the lowest corner and soon after falls out altogether through the meshes. The two beautiful moths called "green silver lines" (*Halias*), whose forewings are of a delicate pale green with two or three white or yellowish lines drawn across them, make cocoons like an inverted boat. Passing to exotic insects, we find some very curious cocoons among the silk-producing Bombyces. One of the most extraordinary is that of the tusser silk moth. This is a large moth of a pale fawn color, with transparent circular windows in the center of its wings; it is a good deal reared in India for the sake of the silk obtained from its cocoon. The cocoon is oval, hard and compact, without loose outlying threads, seeing that it is not anchored as usual, but is suspended at the end of a stout

FIG. 6.—Cocoon of Tusser Silk Moth.

stalk, the further end of which forms a circular loop tightly fastened round some twig of the food plant, so that the cocoon hangs from the bough like a kind of fruit (Fig. 6).

Our next illustrations will be taken from the order Coleoptera, or beetles. Many of these insects feed upon plants, and among these vegetarian groups are several species that construct cocoons. Two of the

most interesting instances may be mentioned, both taken from the beetles called weevils. A weevil may be easily recognized by the peculiar structure of its face; this is prolonged into a longer or shorter beak or snout, sometimes reminding one of an elephant's trunk, and carrying the mouth organs at the tip. *Hypera variabilis* is the name given to a brownish species which feeds upon various leguminous plants, and, while generally common, is sometimes found in absolute profusion. The grub of this creature, a short caterpillar-like being, covers its body with a sticky substance secreted by a gland placed at the tail. When it has eaten its destined amount of lucerne or other leguminous food, and reached its full size, it retires to the underside of a leaf, and begins to construct there, with this same sticky substance, a kind of oval cage consisting of a thin and open network of threads. Within this the little creature enters upon its pupal experience, remaining, of course, still visible from the outside through the meshes of the network. Few natural objects are more graceful and delicate than these little cages, which may often be seen attached to leaves. The construction of the cage is rather a slow business, occupying, although it is not a large structure and the network is but one layer thick, about twenty-four hours in completion. So delicate a structure would, no doubt, stand but little wear and tear, and would be a most imperfect shelter against climatic changes; but fortunately its durability is not greatly put to the test, for the perfect beetle is rapidly developed within, and issues after only a few days of captivity. The genus *Hypera* is a large one, containing sixteen British species, the habits of all of which are similar to those detailed above.

The other instance of beetle cocoons is that of the genus *Cionus*. Here we have half a dozen species of extremely pretty weevils, with large globular bodies, variously colored, and always adorned with raised velvety patches, some of which are rectangular streaks and others circular disks. These beetles are specially attached to one order of plants, the *Scrophulariaceæ*, and particularly to those members of it called figworts (*Scrophularia*). The figworts grow in damp places in tall clusters; they may be known by their disagreeable odor, their succulent stems carrying opposite pairs of smooth, broad, rounded leaves with notched edges, and their bunches of small, deep red, cup-shaped flowers at the top. The flowers do not all open at the same time, so that often there may be seen on the same cluster buds, flowers, and seed vessels. Sometimes the leaves of these plants are seen to be riddled with holes, as though some one had been making them a target for the discharge of small shot; the leaves are then more or less dry and brown. This damage is wrought by the larvæ of weevils belonging to the genus *Cionus*, and a little close inspection will usually reveal the beetles crouching down on the leaves; or failing this, if the eyes be carried to the bunch of flowers, buds, and seed vessels at the top of the stem, a still more careful scrutiny will probably detect a number of oval olive-brown bodies among the rounded buds and seed vessels, and very closely resembling them in appearance (Fig. 7). These are

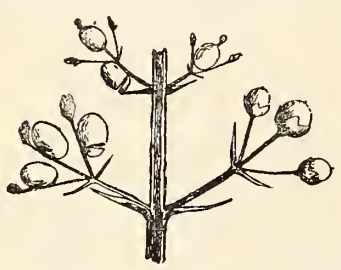


FIG. 7.—Part of Figwort Flower Head, with seed vessels and cocoons of *Cionus scrophulariæ*.

the cocoons of the beetles, and though perfectly exposed, they are yet beautifully concealed by their resemblance to the fruitage of the plant. In many respects the economy of these insects is like that of the genus *Hypera;* there is the same sticky secretion on the larvæ, furnished by a gland at the tail, and as before it is worked up into an oval cocoon to inclose the pupa. But there is this difference, whereas the cocoon of *Hypera* is a network, that of *Cionus* is a continuous papery layer without openings, so that the chrysalis is entirely hidden. The structure, in fact, reminds one of a child's air ball, and within it the chrysalis lies free, rattling against the sides when shaken. Within its balloon-like covering the insect lies for about a week, when it casts its last skin, cuts nearly off a neat segment from the bottom of the cocoon, and crawls out through the hole. From the above it will be seen that these beetle cocoons are not strictly comparable with those of moths, inasmuch as the material of which they are composed is secreted, not by a gland opening beneath the mouth, but by one which opens upon the upper surface of the last segment of the body.

A third order of insects, the Hymenoptera, now claims our attention, for the habit of cocoon forming is widely extended, and occurs among most of the groups of insects whose metamorphosis is complete. Our illustrations will be taken from the parasitic members of this extensive order, which go by the general name of ichneumon flies. They are long-legged, thin-bodied, four-winged insects, with long antennæ and very often with the body terminating in a longer or shorter stick-like ovipositor. Most of them are during their larvahood internal parasites of other insects, their footless maggots living inside the bodies of caterpillars and other larvæ, and subsisting at the expense of the tissues of their hosts, whose ruin they thus achieve. Of these creatures, two extensive and well defined families are recognized—the *Ichneumonidæ* and the *Braconidæ*. These two groups are very similar in general appearance, and certain members of the one family closely mimic certain of the other, so that a novice who did not know exactly what points to look for in endeavoring to distinguish them would probably consider as identical two insects that would be in reality widely different, as would at once become evident if their whole life histories could be simultaneously passed in review. But they may very easily be distinguished by paying attention to the arrangement of the nervures of the forewings. A comparison of the two wings in Fig. 8 will at once make this plain. In both there is a dark spot, called the "stigma," more than half way along the upper margin of the wing; in the Ichneumonid the space immediately beneath this forms a large cell of a more or less distinctly five-sided outline and with its lower and outer edge

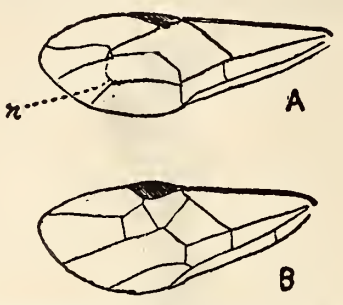



FIG. 8.—Forewings of (A) Ichneumonid, (B) Braconid.

concave; in the Braconid the same space is occupied by three cells, each roughly four-sided. The little nervure marked *n* also is present in the one and absent in the other. There is endless diversity in the actual forms of these cells in the different genera, but the general plan remains much the same, and will usually serve to distinguish a Braconid from an Ichneumonid pretty readily.

Both of these groups of parasites make cocoons, many of which closely resemble those of the Lepidoptera, except that they are, most of them, smaller. But as the larvæ are naked maggots instead of hairy caterpillars, of course the cocoons are always composed purely of silk, and contain no hairs. As might be expected from the shape of the perfect insects, the cocoons are of a long, narrow form, equally rounded at each end; they are of all shades of color, from the purest white to the deepest black. A large reddish-yellow Ichneumonid, *Paniscus testaceus* by name, which is very destructive to the puss moth, makes a thick, rough, dull blackish-brown cocoon. Except by those who rear the hosts, these cocoons are not likely to be seen, as they are to be found only inside the cocoon of the moth; for the parasite does not reach maturity till after its host has immured itself. Another ichneumon, strikingly like the last, and easily mistaken for it, though belonging to a different genus (*Ophion*), makes a totally different cocoon; it is much like those of the egger moths, only narrower—oval, yellowish-brown, and covered with a network of black threads. A species of Braconid (*Zele testaceator*), exceedingly like this again, though much less common, provides for itself a most elegant envelope of a satiny white appearance. Thus we have three species which superficially bear a close resemblance to one another, but which construct totally different cocoons. Some of the smaller kinds make very pretty cocoons; a little Ichneumonid parasitic on the weevil (*Hypera variabilis*), above described, makes a minute reddish-brown one with a neat white band round the middle (Fig. 9), and many others are similarly adorned.

FIG. 9.—Banded and Tailed Cocoons of Ichneumon Flies.

Many of these cocoons may be found among the herbage in woods, hedges, etc., though their small size of course necessitates a careful search; after the disclosure of the flies, they appear to last for some months, and may be found lying about among dead leaves and other rubbish.

Among Braconids, there is a large number of small species which are great scourges to the caterpillars of moths and butterflies; they live gregariously in their hosts, and when full fed they eat their way out, and construct their neat little white, buff, or yellow cocoons in clusters round and over the shriveled remains of their victim. The caterpillar of the common white butterfly (*Pieris rapæ*) may often be seen on walls, treated in this way, its crumpled and distorted carcass being almost hidden under a cluster of little oval silken spindles. One curious genus makes glossy brown cocoons, from one end of which a long, stout, and much twisted anchoring thread proceeds, to the extent of some three or four times the length of the cocoon (Fig. 9); the method of its formation is not easy to understand. Some gregarious Braconids unite their cocoons together, deeply embedding them in a common mass of silk which entirely conceals their outlines, and makes the whole look more like a single cocoon of a moderate sized moth than a cluster of small ones. The possibility of such an association, of course, depends upon their all reaching the pupating stage at the same time; but there is no difficulty about this, for the eggs are all deposited in the host's body on the same occasion, and as the maggots are always completely surrounded by their food, the juices and tissues of their host, they all have equal chances of development, and therefore reach maturity together. The flies also emerge in company.

## VARIABLE STARS.

By Prof. C. A. YOUNG.

FOR the most part the stars maintain their places and brightness apparently unchanged: the heavens of to-day are substantially the same as those of Job and Homer. The comparison of a modern star catalogue with that of Hipparchus as preserved by Ptolemy shows that with few and generally slight exceptions the principal stars still hold the same relative positions and the same rank in brightness which they did two thousand years ago. And yet we know that all the time they have been swiftly moving in all directions at rates sometimes exceeding one hundred miles a second—some approaching us and some receding. Then, too, they have all been growing old together, some advancing from stellar infancy toward adult vigor and some descending toward extinction. The apparent permanence is apparent only—due simply to the fact that the scale of human life and all our terrestrial surroundings is practically infinitesimal as compared with that of the stellar universe. Even the nearest star is so remote that if it were rushing directly toward us with the speed of one hundred miles a second it would gain in brightness only about two and a half per cent. in a century, an amount barely observable by our best photometers. As to changes due merely to advancing age, a century bears only some such ratio to the lifetime of a star as a single minute to that of an aged man.

But while all this is true there are several hundred stars which are known as "variables," and undergo considerable changes of brightness, sometimes quite rapidly. They form the subject of a most interesting and important chapter in astronomy—a chapter which may be regarded as opened by Tycho's observations of the marvelous star of 1572, but even yet only begun; in fact, nearly all the systematic work that has been done in this line has been accomplished within the last sixty years.

These "variables" may be roughly classified as follows. First, we have a few stars that seem to be gradually and more or less steadily growing brighter or fainter, judging from their present rank as compared with that which they used to hold; Alpha Geminorum is a case in point, being now distinctly fainter than its neighbor, Beta, although presumably when Bayer assigned the letters, about eight hundred years ago, the reverse was the case. A second class consists of those which oscillate in brightness, but without any apparent regularity, like Eta Argus and Alpha Orionis. The third class is made up of the so-called "temporary stars"—stars which suddenly shine out, and after a few months disappear or become very faint. There have been about a dozen instances of this kind, the last being the "new star in Auriga," which appeared in 1892. The fourth class, and by far the most numerous, is made up of those which vary periodically in brightness in a manner which admits of mathematical prediction. Among these periodic stars at least three sub-classes are to be distinguished: (*a*) those which at regular intervals brighten up for a comparatively short time and then fall back to their normal condition until the next maximum. These are often referred to as the "Omicron Ceti type," because that star usually called Mira, or the "wonderful," is the most conspicuous and longest known of all that belong to it. The majority of the periodic stars belong to this sub-class, and generally repeat their changes about once a year, though their periods range all the way from one hundred and ten days to six hundred and ten. (*b*) The second sub-class includes the stars which, like Beta Lyræ, are in a continual state of activity; they often present more than one maximum of brightness within a single complete period, which is usually somewhere between five days and sixty. (*c*) Finally, we have the ten stars of the so-called "Algol type," which behave in a manner precisely the opposite of that of the stars of the first sub-class: *i. e.*, they undergo periodical diminutions or eclipses of their light, remaining for the remainder of the time steadily bright. Their periods are always short, ranging from seven hours to ten days. The type of the class is Beta Persei, better known as Algol.

The variations of the stars of this class can be very simply explained as merely due to actual eclipses, and the truth of this explanation has been practically established within the last three years by the spectroscopic work of Vogel, at Potsdam. The period of Algol is a trifle under sixty-nine hours, and the photographs show that seventeen hours before the obscuration the lines of its spectrum are displaced toward the red by an amount which indicates that it is then receding from us at the rate of about twenty-seven miles a second, while seventeen hours after the obscuration it is found to be approaching at the same rate; in short, the observations prove that the star is moving in an orbit nearly circular, a little more than two million miles in diameter, and lying in a plane nearly passing through the observer. Now if the periodical obscuration is really caused by the interposition of an eclipsing body, the bright star must necessarily circulate around the common center of gravity between itself and its dusky attendant in just this sort of way, and the detection of such motion falls little short of a demonstration of the hypothesis. We may go further; taking into account the fact that the whole "eclipse" lasts for about eight hours, and that the star loses about two thirds of its light at the time of maximum obscuration (when the brightness remains without change for about twenty minutes), it can be safely inferred that the dark attendant is just about four fifths the diameter of the bright star, and about half as heavy. Also that the distance between the two is about 3,250,000 miles, the diameters of the two bodies being respectively about 1,060,000 and 840,000 miles. Moreover, the combined mass of the two is about two thirds that of the sun, and their density only one fifth as great—not much exceeding that of cork. Nor is this all; since the discovery of the variability of the star in 1782, a slight but distinct variation of the period has been observed, of such a character as to set the times of eclipse alternately backward and forward by about two hours and a half in the interval between 1804 and 1869. From this, combined with certain minute irregularities in the "proper motion" of the star, Mr. Chandler two years ago showed that Algol and its companion must be moving together in a great orbit, nearly as large as that of the planet Uranus, completing the revolution in a period of about one hundred and thirty years; at least, such a revolution would account for the facts, while no other hypothesis yet proposed will do so. And if this revolution is real, it must be around some neighboring body, so faintly luminous that it has not yet been detected. The story of Algol opens to us a new universe of "dark stars"—bodies invisible, but massive and powerful. Presum

ably the other stars of the Algol class admit of a similar explanation, although as yet they have not been spectroscopically studied, being all of them small, and too faint for investigation with the instruments at present available. When the great Yerkes telescope, now nearing completion, is mounted at Lake Geneva it is expected that one of its earliest applications will be to investigations of this sort. It should be added also that certain peculiarities in the light curves of some of these stars seem to indicate that we have not quite reached the bottom of the matter—that in addition to the eclipse, and perhaps caused by it, there are real variations in the light-giving power of the star.

As to the other classes of variables, there is no such satisfactory explanation, nor any generally received theory. In the case of Beta Lyræ and its congeners, we have apparently mechanical and other causes combined—the axial revolution of a star, perhaps, or possibly the whirling of a group of stars, accompanied by tidal changes in the brightness and spectroscopic characteristics of their light: for while the minima of the Algol variables are not accompanied by any alteration of the character of the lines in their spectra, it is not so with the other variables; their spectra are almost all of them characterized by bright lines, which become especially brillant at the time of maximum brightness. Beta Lyræ presents conspicuously in its spectrum both bright and dark lines, due to hydrogen; and these shift back and forth with reference to each other in such a way as apparently to indicate the presence of two or more bodies whirling around each other, one of them giving the ordinary dark line spectrum and the other the bright line spectrum of the gas.

The stars of the first and much the most numerous sub-class are nearly all distinctly red, and show in their spectra the bright lines of hydrogen, but do not as yet furnish any certain evidence that their periodicity is of a mechanical origin—due, that is, to a revolution of some sort. Possibly the explanation proposed by Lockyer may ultimately be verified—that the sudden evolution of light is due to the collision between two swarms of meteors which revolve around their common center of gravity, and brush against each other as they pass their perihelion point. But the periodicity of this class of variables is hardly regular enough to suit this explanation, and the sudden outburst of the bright lines in the spectrum of a star suggests rather some such action, though on a vastly grander scale, as that which causes the sun spots and the solar prominences—causes operating within the star itself.

As to the "temporary stars" opinion is much divided. On the one hand, Lockyer and his numerous followers attribute the phenomena to the collision of swarms of meteors, while on the other, Huggins and Vogel are disposed to assimilate them to the solar eruptions. The latest instance of the kind—the "Nova Aurigæ" already alluded to—which appeared in February, 1892, has been most exhaustively studied by a great number of observers. It is agreed on all hands that at first its spectrum was full of bright lines, and dark lines also; and that among these lines those of hydrogen, both bright and dark, were specially conspicuous, just as in the spectrum of Beta Lyræ; and, moreover, that the bright lines were so shifted toward the red end of the spectrum with respect to the dark lines as to indicate the tremendous relative velocity of more than five hundred miles a second in the two masses to which the lines were respectively due. As to the other lines there was dispute. Lockyer maintained that they were the same that are found in the nebulæ; other observers, no doubt correctly, identified them with certain lines which are conspicuous in the spectrum of the solar chromosphere in every important eruption. The star faded to apparent extinction in April, 1892, but most unexpectedly brightened up again the following August, though not so as to be seen with the naked eye; with the telescope it is still visible. Its spectrum, however, has undergone a remarkable transformation, many of the lines which were formerly most conspicuous having disappeared, while others have taken their place, so that at present it is unquestionably a nebular spectrum. As Mr. Campbell, of the Lick Observatory, who has perhaps the best right to speak authoritatively, puts it, "The lines of the present spectrum do not occupy the positions of the lines in the February spectrum, nor the positions of the lines in the solar chromosphere, nor the positions of the lines in the spectra of any of the bright line stars; they do occupy the positions of the lines in the nebulæ, and the spectrum resembles nebula spectra as closely as well known nebula spectra resemble each other." This is said in answer to some high authorities who find it difficult to admit so surprising a fact as such a transformation. It certainly looks as if we had to do with a reversion of the ordinary course of stellar development; instead of the formation of a star by the slow condensation of a nebula, we seem to have the sudden formation of a nebula by the violent explosion of a star. But speculation on so small a basis of fact is hardly sound.

I must not close without a reference to the important, though unpretending, catalogue of variable stars just published by Mr. Chandler, of Cambridge, who, since the death of Schönfeld, may be regarded as at the head of the department of variable stars, so far at least as relates to the mathematical aspects of the subject. The first step to any real mastery of it must be an accurate collection of facts, such as this catalogue embodies. It gives a list of all the stars which are certainly known at present to be variable, two hundred and sixty in number (sixty-two of them naked eye stars) and adds a subsidiary list of one hundred more which are more or less strongly suspected. Of the two hundred and sixty, about thirty-five are known to be irregular and unpredictable in their variations, and about as many more are still in doubt as regards the periodicity of their changes. The remaining one hundred and ninety are clearly periodic, and Mr. Chandler gives for each of them the formula by means of which its variations can be predicted, thus embodying in a few modest figures the result of an enormous amount of skillful labor. Ten of the variables belong to the Algol class, about twenty-five to that of Beta Lyræ, and the rest resemble Omicron Ceti more or less perfectly. It should be added also that the list of variables is constantly growing—chiefly, of course, among the telescopic stars.—*Popular Science News.*

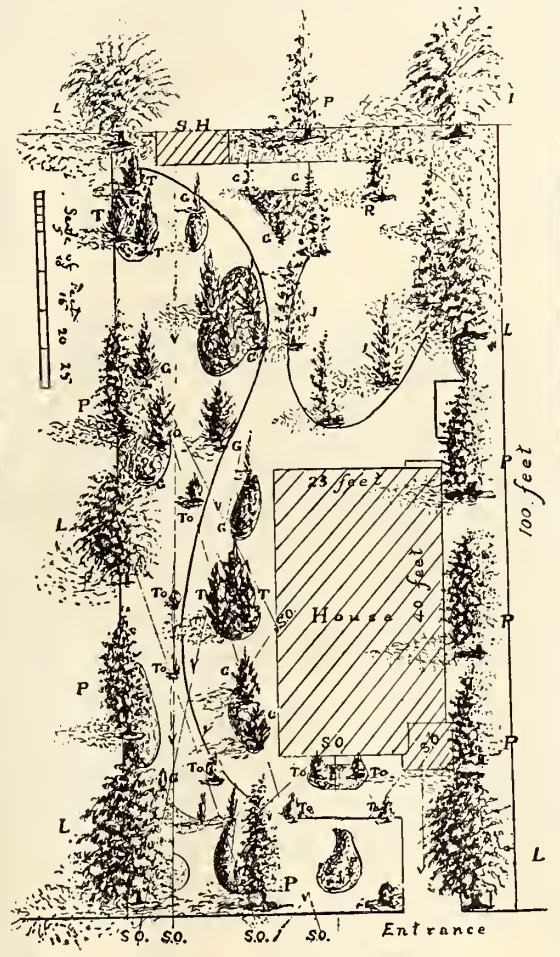
## HOME GROUND ARRANGEMENT.

THE plants we recommend are not intended to limit the reader to those named, but to demonstrate that results are attained only by following character. We have selected the Western Arbor Vitæ for the shrub effects, and do not allow anything to interfere with its prerogatives in its views, but in adding more variety to the garden we select suitable forms for the development of its particular character. This genera of plants is suitable to the colder parts of America; the genera of Biota can be used in the Southern States.

The shade trees for our plot are Tilia Europæa, the linden or lime, trees that give dense shade; when in flower they fill the air with delicate perfume, and they should be in more general cultivation.

Pinus larico, the Corsican pine, is well known by its erect habit, which makes it particularly suitable for small places. The oval space behind the house shows three silver Irish junipers (*Juniperus communis hibernica*). Back of this oval is planted Salisburia adiantifolia, the maiden hair tree or Gingko, one of the remarkable trees of Japan, a plant combining quick growth with a curious light effect.

The five beds in front of the house are for summer flowers; the nine oval groups shown on plan are to be planted with suitable herbaceous plants according to the owner's requirements. In addition to the shrubs already named the three figures on the left hand boundary should have a dozen hollyhocks distributed, four in a bed; then generally over all the groups, herbaceous plants, phloxes, double rockets (Hesperia matronalis), Penststemon, not forgetting the sweet smelling common wall flower. The beds will then be ready for their final carpet, so that the whole will be completely planted and cover the intervals of soil between the plants we have named; for this we




A VILLA PLOT 50 FEET WIDE AND 100 FEET DEEP.

recommend Ampelopsis Veitchii (Japan ivy), which carpets the ground as well as walls when the opportunity is given it. The border in the rear of plot may be used for vegetables.

The general arrangement of this plot is gravel around the house and the beds set in the gravel will require permanent edgings. We recommend it made to show a stone work; this may be easily done by a bricklayer, who should lay a brick flat long ways around the figures, letting its top surface be two inches below the general level to act as a foundation for another brick set on its edge all the way around on the top of it. These require to be kept in the curves as perfectly as possible; then the bricklayer will take his concrete, made of cement and sand, and whirl the whole figure into perfect form. The three trees in the gravel on the right hand side of the house must have plenty of good soil provided for their roots, to be covered with a light coating of gravel, not over two inches deep, so as to carry out the plan.

The usually vacant ground along the side of the house can thus be turned into a perfect charm to both the house and road prospects. Wherever a house is made pleasant to the sight its material value is largely increased, and above all this general good is produced, for a pleasing natural effect sways the life of all beholders, knowingly or unknowingly, and he who produces a beautiful prospect is a public benefactor.

Our plan shows a perpetual garden residence on a plot of land 100×50 feet, and by adopting the natural arrangements you may imagine yourself taking fifty different views over it; you will never see two alike, and more than this, you will always find each one in harmony, in repose, in character, and possessing no objectionable features, these being planted away.

Narrow views are weak points; we show none, but instead direct the eye upon every occasion to the length of the ground by the formation of groups as shown on the plan. Harmony is retained by adopting the character of the Arbor Vitæ in mid-distance; repose is acquired by uniting the ground line, mid-distance and sky line together.

ABBREVIATION OF PLAN.

L—Tilia Europæa.
J—Juniperus communis hibernica.
T—Thuja occidentalis Vervæneana.
G—Thuja occidentalis, George Peabody.
To—Thuja occidentalis, Tom Thumb.
P—Pinus larico.
R—Salisburia adiantifolia.
S,H—Summer house.
S,O—Sites of observation.
V—Lines of sight.
H—House.
E—Entrance. —*American Gardening.*

## ROSE CULTURE IN BULGARIA.*

THE culture of roses in Bulgaria for the purpose of extracting the otto of rose is not only the oldest and most attractive industry of the country, but also quite exclusively our own. While roses are found all over the world and are grown everywhere in garden beds, in Bulgaria they are grown in extensive fields, as you grow here the potato or the vine. This industry, however, is confined only to one special district in Bulgaria, which is comprised in the eight counties above mentioned, with Kizanlik as their central town, called in consequence the capital of the rose district. The rose district extends along that portion of the southern slopes of the Balkan Mountains, comprising in itself the whole branch range of the Little Balkans, which shoots out of the main Balkans and forms one of its chief arms. The average length of the rose district is about eighty miles, and its average width is about thirty miles. Its average elevation is about 1,300 feet above the level of the sea. The average height of the Balkans along the rose district is about 5,600 feet, while that of the Little Balkans is about 3,700 feet.

Attempts have often been made to grow roses all over Bulgaria, but they have all proved a failure. It is true that roses have been grown and are grown to this day in Persia, India, Egypt and China for this purpose, but they hardly produce any otto of rose. They produce almost exclusively rosewater, and it is chiefly used for local consumption. In the "Maritime Alps" of southern France, and especially in Cannes and Grasse, they grow quite extensively the "Provence rose," and they extract from it a peculiar otto of rose, but the quantity is very limited and they chiefly use their flowers to make pomades and rosewater. In Leipzig, Germany, they also grow the roses, but with very little success. Almost in all the other places where the roses are grown they lack the peculiar advantages of climate we possess, and have in consequence to use twice and even thrice the quantity of flowers to make the same amount of otto. The hottest weather we ever experience in summer is 88° F. and the coldest of winter is rarely under 15° F. above zero. Then, during the harvest and the distillation season, which is in the latter part of May and the first part of June, we have regular showers of rain, and in the mornings heavy falls of dew—both absolutely necessary for the otto of rose distillation.

After the Russo-Turkish war in 1877–78, when Bulgaria was separated from Turkey and constituted into an independent principality, the Turkish government spent thousands of dollars in trying to replant the Kizanlik rose in Asia Minor, and many scores of rose gardens were planted around Broussa, but to no purpose. The gardens grew, thrived and yielded plenty of flowers, but when distilled they got only rosewater, and very little otto, and the work in consequence could not pay. It is the peculiarity of the soil and chiefly that of the atmosphere of this special district in Bulgaria, caused by the peculiar formation of the mountain ranges surrounding it, which make the roses thrive and yield sufficient otto of rose to pay for the very laborious work that the culture entails.

The roses we grow are only of two kinds: red and white. The red rose, which affords the chief ingredient of the otto, is of the variety known as *Rosa Damascena*, and the white rose is a variety of the musk rose (*Rosa Muschatta*). These two varieties are grown nearly everywhere, but nowhere in the world do they resemble our roses.

Our red rose is a semi-double light red rose like the French *rose du roi*, having from thirty to thirty-six petals and possessing an extremely rich and fragrant odor. There are now in the entire rose district over 5,500 acres of rose gardens scattered in 150 different villages, and at the end of May, when the roses begin to blossom, the whole atmosphere in the district is full of their aroma.

The growing of the rose is very much like the growth of the vine, and the planting of a rose garden is similar to that of a vineyard. After the ground has been prepared by tilling and manuring, ditches are made in rows, about a foot and a half in depth and width and a yard and a half apart. At the bottom of these ditches soft earth mixed with manure is spread, on which the roots forming the bushes of the new rose garden and taken from old bushes are firmly stuck vertically, and then well covered with the earth and manure. This is generally done in the spring, when the rain showers abound. The roses thus planted soon take root, and in less than two months send up soft, glossy, green shoots, which in a year become about a foot high. In the second year they are over two feet high, and yield a few rose flowers. The first crop worth gathering is in the third year, and in the fifth year they attain their full growth. They reach then a height of about six feet, the bushes forming thick rows of clustered rose trees and continuing to yield rich crops of flowers for a period of twenty years, and in some localities twenty-five years, after the lapse of which time they become old, begin to die from the winter's cold and frost, and yield but few flowers. Then the old rose bushes are dug out and the garden is planted anew.

A rose garden requires constant care. During the year it is hoed three times. In autumn the roots are covered up with earth to guard them from the win-

* From the World's Fair circular of Shipkoff & Co., Kizanlik.

ter's cold. In spring that earth is thrown off and the bushes are pruned and every other year the garden is manured.

The roses yield only one crop every year. The rose harvest begins in the second part of May, and as the weather is dry and hot or cool and rainy during the blossoming season, it may last from eighteen to thirty days. During the whole harvest the distillation of the crop is carried on. Morning after morning, hours before sunrise groups of young maidens and boys, all dressed in their beautiful bright colored native costumes, proceed with sweet songs to the rose gardens to gather the newly opened buds, while the heavy morning dew is still on the blossoms. Nothing can present a more captivating scene than a rose garden in bloom, with its gayly attired peasant girls gathering the roses, and its nightingales—those romantic lovers of the *Regina florum*—trying in most melodious song to outsing the maidens.

As soon as the roses are gathered they are taken to the distillery, spread in cool and shady rooms and gradually distilled during the day. The alembics used for this purpose are of the simplest kind. They consist of a convex tinned copper boiler, narrowed at the top to a neck on which is fixed a spherical head piece with a tube on one side, to which is attached the condensing tube, sloping down and passing through the condenser or refrigerator, a large vessel into which cold water is constantly running. The capacity of the boiler is about 250 pounds of water. In distilling the roses from twenty to twenty-five pounds of flowers are put in it and from five to six times that much of water, thus filling nearly three-fourths of the boiler. This done the headpiece and condensing tube are tightly attached, the fire started and the distilling of its contents begun. This is carried on about forty-five minutes, until thirty to thirty-five pounds of rosewater are extracted from each boiler. The boilers are then emptied, cleansed with clear water and the same process is repeated until all the morning gathered flowers are distilled. The rosewater extracted from the first distillation is redistilled in the same way, only in this second distillation from 100 to 120 pounds of rosewater is used, and out of it they extract some thirty to thirty-five pounds of second rosewater. This double distilled rosewater is very strong in odor and quite turbid in appearance; it is full of tiny yellow white oily globules floating in it, and as the bottle is filled they rise up and gather on the top of the long-necked bottles in which the rosewater runs. These globules are the otto of rose, and when all the oil has settled on the tops of the bottles it is skimmed and put in separate bottles by little conic-like spoons, with a little hole in the bottom, large enough to let the water run out, but not the oil.

There are at present about 5,500 acres of rose gardens in the entire rose district, which produce annually from 17,000,000 to 21,000,000 pounds of flowers or about 5,400,000,000 roses. A rose garden an acre large yields under the most favorable circumstances from 4,000 to 4,500 pounds of roses, out of which amount is extracted from twenty to twenty-five ounces of otto of rose. It takes generally from 180 to 220 pounds of roses to make one ounce of otto of rose, and there are about 300 roses to the pound. The total amount of otto of rose produced annually in the whole district varies according to the seasons, from 60,000 to 100,000 ounces of otto of rose. Last year the whole crop amounted to about 60,000 ounces, while this year the crop will not exceed the total sum of 80,000 ounces. Nothing can be positively known of the yield of a crop before it has been fully distilled. Many things damage a crop, as hailstorms in autumn, excessive cold in winter, early and deceptive spring, white frost during the budding season, and hot and dry weather during the harvest. The last two cause the greatest damage to a crop.

Nearly all the otto of rose produced in Bulgaria is exported for consumption abroad. Its three largest markets are Paris, London and New York, from where it is distributed all over the world. All the principal perfumers procure now their supply direct from the native manufacturers and exporters.

## PARA.

THE State of Para is the most northern of the United States of Brazil and occupies a vast region. Its territory is estimated at 443,896 square miles, comprising one-seventh of the Brazilian territory and one-thirteenth of the surface of South America. Not only is there such a vast area, but the natural resources are believed to be capable of supporting half the population of Europe. Yet the population is more sparse than that of Iceland, being only about 1·11 per square mile.

India rubber represents nearly two-thirds of the total value of production of the State of Para, and contributes to the state and municipal revenues 25 per cent. of their total amount, with neither loss nor impoverishment to the producer. There are many other valuable products of this state, the export of which, largely to the United States, is constantly on the increase, and the foreign trade gives employment to a number of important steamship lines. The Amazon Steam Navigation Co. (limited), operated with London capital, has a fleet of twenty-nine steamers, whose combined trips last year on the Amazon and its tributaries amounted to over 500,000 miles, one of the lines communicating directly with the republic of Peru and others indirectly with Bolivia and Venezuela. Its income has increased from 34,205 milreis in 1853 to more than 4,000,000 milreis last year. The Maranham Coast Co. employ five steamers, and the Lloyd Brazileira employ twelve steamers, all for interior navigation. The Para and Amazon Co. employ eight paddle wheel steamers. The steamers of the Booth line, established twenty-five years ago, navigate regularly between Para and Manaos and New York and the principal European ports. Ten steamers are employed. Besides, the Red Cross line and the United States and Brazil Mail Steamship Co. employ together fourteen steamers for ocean transportation, and the Lloyd Brazileira seven steamers. The book "The State of Para" enumerates five banks established in Para, besides branches of English banks. There are also two local insurance companies, the Grao-Para Water Co., a paper factory, telephone company, a street car line using American cars, the Para Gas Co., a cold storage company for preserving meats by the freezing system, and many other corporations either projected or in operation.

It is predicted that sooner or later Para will become an important industrial country. Already sugar mills, brick-making machinery and steam sawmills are in operation. Para has 101 sugar estates, thirty-six steam sawmills and thirty-five brick yards. There are also soap factories, oil factories and various sorts of shops and foundries in the city of Para. In the State there are forty-one printing offices and thirty-two newspapers. During the past year there were constructed in the city of Para more than 700 dwellings.

Popular prejudice, to quote from "The State of Para," has always been very great against the climate of this region, considered by many to be the focus of malarial fevers. Passages are given from numerous writers to show that the climate is very much more moderate than might be supposed from the nearness of the city of Para to the equator. Herbert H. Smith writes: "At Para, it is true, people complain of the sultry days, but you shall see a dozen more sultry ones during August in New York. 90° Fah. is about the highest temperature of sunny afternoons, and the evenings are delightfully cool."—*India Rubber World.*

## LIME AND ALKALIES UPON INVERT SUGAR.

A NUMBER of experiments have been made by Jesser to ascertain the amount and nature of the non-saccharine products resulting from the action of lime and alkalies upon the invert sugar of beet juice, employing solutions which, like those occurring in practice, contain 0·2–0·4 per cent. Caustic lime acts upon glucose at 80° C., and more intensely at 100° C., producing a decomposition, so that the neutral solution after being twice saturated still contains the same amount of lime, but combined with a smaller amount of organic matter in proportion to the amount of action which has gone on. Levulose is as much acted on at 80° C. as glucose at 100° C. Invert sugar behaves like glucose, and the acids formed neutralize 1·5 molecules of lime for every 2 molecules of glucose decomposed. Unless the action of the lime is very slight, organic substances are always produced which neither reduce nor polarize, before or after inversion, and in neutral solution are scarcely precipitated by lead acetate, but strongly by an ammoniacal solution of this reagent. Alkali carbonates produce an almost immediate precipitate with these lime compounds, and the precipitation is considerable at the ordinary temperature within an hour. On boiling, a large part of what remains dissolved is thrown down. Invert sugar is acted upon in much the same manner by caustic potash, but this solution gives a strong precipitate with lead acetate. At the boiling point, and in dilute solution, the reaction proceeds so regularly it may be made quantitative, an excess of alkali being added and titrated back with acid, the change of color with a litmus indicator being thus rendered sharper. An excess of alkali together with lime acts in precisely the same way. As regards the color of the solutions it may be noted: 1. The moderate action of lime produces a brownish red dull liquid, while on more vigorous action it becomes brighter and more fiery; the subsequent addition of an alkali carbonate produces in the former case a slight, in the latter a considerable, darkening. 2. Moderate action of an alkali gives a clear yellow solution; more energetic action renders it dark and yellowish brown. 3. Energetic action of lime and alkali simultaneously renders it very bright and of a fiery color. When the invert sugar in a diffusion liquid which contains 10 per cent. of sugar and 0·1 per cent. of invert sugar is destroyed, the alkalinity, expressed in lime, is reduced by 0·2 per cent—*Chem. Zeit.*

## BAUME'S HYDROMETER, OR AREOMETER.

By HENRY WURTZ, Ph.D.

FEW instruments are in use which have to the present time become of more importance to practical men, and, therefore, indirectly to the mass of mankind, than that which is called Baumé's hydrometer. There are two distinct instruments that come under this name. One of these is used for determining the densities of liquids heavier than water, such as acids, saline and alkaline solutions, sirups, glycerines, milk, urine, etc.; the other—which constitutes our special subject of consideration at present—for determining the densities of oils, naphthas, alcohols and spirits, ethers, essential oils and terpenes, fats and waxes (when melted), and generally all substances lighter than water—the weight of a cubic inch of water at a certain given temperature, and at the mean barometric pressure, 30 inches of mercury, being the standard universally adopted, by the English-speaking nations at least.

It is a remarkable fact that it is but about four years since the value of this standard—the weight of the cubic inch of water—has been known with what may be called scientific accuracy. Attempts were made in 1824 to establish it by act of Parliament, following figures that were subsequently ascertained to date nearly a century ago, when chemical balances and weights were far from possessing the delicacy and precision now reached. It was enacted in 1824 that the cubic inch of distilled water at 62° F. and 30 inches of barometer must weigh precisely 252·458 grains. This figure has passed into the literature of science, and most of the chemical and technological text books present it as a finality. Thus, for example, in Fownes' Manual of Chemistry, which has been used more extensively than any other in our American schools, we find: "A cubic inch of water at 62° F. weighs 252·45 grains." (Edition of 1873, page 135.)

It appears, however, that about 1878 suspicions arose that Nature might refuse to be controlled even by an act of Parliament, and that the balance, as we now have it, must be again appealed to, to establish with exactness this cornerstone figure. About 1889 it was announced by the London Board of Trade that their experts had been working out this problem for more than ten years, and had finally decided that the cubic inch of distilled water at 62° F. weighs 252·286 grains, varying, therefore, from the Parliamentary fiat by 0·172 grain. In a cubic foot of water this amounts to 297·216 grains, or more than two-thirds of an ounce avoirdupois; and in a United States gallon of 231 cubic inches to 39¾ grains. In an oil barrel of 42 gallons, the error thus corrected is 1,669½ grains, considerably more than three ounces avoirdupois. The United States gallon by the new figure is 58,278·066 grains=8·32544 pounds avoirdupois, or 8 pounds, 5 ounces, 90½ grains. (See the table below.) By the Parliamentary figure our gallon has been hitherto computed at 58,317·798 grains= 8·331114 pounds, or 8 pounds, 5 ounces, 130½ grains.

These remarks appear to the writer—and, it is hoped, will appear to the reader—a sufficient apology for the presentation here of a new table for the conversion of the degrees of the Baume *pèse esprit* hydrometer into actual weighings. Another similar table, for the *pèse acide* instrument, will also be given at an early day.

It is a curious circumstance that the Baume hydrometer scale—at least the one applied to liquids lighter than water—has, in spite of its competition with some 15 or 20 other hydrometers, which have been more or less in use at intervals during a century, held its own, and has made its way into almost universal use throughout the world. To a scientist, there appear two somewhat serious objections to it:

*First*, its standard is arbitrary, in this respect resembling that of Fahrenheit's thermometer. Its scale, so far as can now be made out, had its starting point in a solution made by Baumé of 15 parts of what he designated as "sea salt" in 85 parts of water. By this solution he marked the 15th degree on his scale. No chemist has since been able to verify this figure with exactness.

Some results of such attempts are here cited:

| | DIFFERENCES FROM BAUME'S RESULT. | | | | |
|---|---|---|---|---|---|
| Delezennes, at 54½° F. | at 10° B., 1·077; | at 20°, 1·167; | at 40°, 1·4: | at 60°, 1·75; | at 70°, 2·0 |
| Francœur, " | " " 1·07; | " 1·152; | " 1·357; | " 1·75; | " 1·854 |
| Gilpin, " | " " 1·075: | " 1·161: | " 1·384; | " 1·714; | " 1·946 |
| Morozeau, " | " " 1·075; | " 1·161; | " 1·384; | " 1·711: | " 1·942 |
| Bohnenberger, at 57½° F | " " 1·069; | " 1·148; | " 1·347: | " — | " — |
| Poggiale | " " 1·075; | " 1·161; | " 1·383; | " 1·711; | " 1·946 |
| Graham | " " 1·073; | " 1·157; | " 1·375; | " 1·69; | " 1·909 |

Berthelot and others have found similar discrepancies. These figures prove not only that Baumé's original determination is of little or no value, but further, that his method is apparently not susceptible of giving a precise and invariable standard. This fact has been much speculated on, and it is generally concluded to be due to impurity in Baumé's salt. The present writer does not accept this view, there being another explanation, namely, that it is undeniable, and has been insisted on by himself for many years, that specific gravities are not fixed, inherent and immutable qualities of saline bodies, or of any bodies whatever. They vary, within certain limits, and according to certain laws. These laws the writer has been studying for twenty years. It follows that *solutions* of salts may and do vary also in density. Hence Baumé's standard cannot be realized at all with certainty and precision.

For these reasons, there has been much dispute about the correct formulation of the Baumé degrees, and their conversion into specific gravity figures and the converse. The formula which has been settled upon and is employed is given below.

The second reason why the Baumé *pèse esprit* instrument is not in accordance with scientific habitudes is that the order of the scale is the reverse of the order of densities—that is, the smaller degrees correspond to the heavier liquids. This does not apply to the *pèse acide* instrument. This, which confuses the minds of beginners, easily becomes familiar to the practiced expert. Nevertheless, it causes embarrassment to those not expert in this field, who are often led into mistakes by forgetfulness of this peculiarity of the system.

In spite of the scientific objections that have been briefly discussed, there must be some feature about the Baumé instruments highly acceptable and attractive to practical men, to account for its wide use. Both instruments are universally employed in this country; but in England, for liquids heavier than water, another areometer, that of Twaddell, is used instead, the reasons given being that the degrees are smaller, and the rule converting them into actual specific gravities simpler and easier of application. The *pèse esprit* is, however, in universal use in England also, and both of them largely throughout Europe.

The following table, besides being founded on the new and more accurate determination of the weight of the cubic inch of water, already explained, is fuller and carried out to more places of decimals in column 3 than any hitherto published, so far as the writer knows. Column 4 is probably altogether novel, and, it is hoped, may prove useful, in certain cases, to practical men.

The formulas used in conversion of the degrees of the *pèse esprit* scale to densities and *vice versa* are those of Dr. Pile as adopted in the United States Dispensatory of Wood & Bache.

$$\text{Density} = \frac{140}{\text{Deg. B.} + 130} \quad \text{and}$$

$$\text{Deg. B} = \frac{140}{\text{Density}} - 130$$

Although several other expressions have been proposed and used, yet throughout the literature of the subject the above are most frequently recommended.

Instead of formulas, the modes of getting the figures in columns 3 and 4 of the table will here be stated as simple arithmetical rules.

1. *Column* 3. The figure representing the density in column 2 is multiplied into 8·32544, the true weight in pounds of a gallon of water.

2. *Column* 4. Throw off the first figure in column 3, and multiply the decimal fraction left by 7,000. If the

product obtained is larger than 437·5, divide it by this. The whole number in this second product will be ounces, and the decimal fraction will be grains and decimals thereof. If the first product is smaller than 437·5, the ounces are = 0, and the first product represents the grains and decimals thereof.

3. To reduce from 62° F. to any other standard of temperature. If such temperature is below 62°, add 4·83 grains to column 4 for each degree; if above 62°, deduct 4·83 grains for each degree.

TABLE OF DENSITIES AND WEIGHTS (AT 62° F. AND 30 INCHES BAROMETER) PER UNITED STATES GALLON OF 231 CUBIC INCHES; CORRESPONDING TO THE DEGREES OF BAUME'S HYDROMETER FOR LIGHT LIQUIDS. BY HENRY WURTZ, PH.D.

| 1. | 2. | 3. | 4. | | |
|---|---|---|---|---|---|
| | | | In one gallon of 231 cubic inches. | | |
| Degrees B. | Specific Gravities or Densities. | Avoirdupois Lb. per Gallon. | Lb. | Oz. | Grains. |
| 10 | 1·0000 (Water) | 8·32544 | 8· | 5· | 90½ |
| 11 | 0·9929 | 8·26633 | 8· | 4· | 114 |
| 12 | 0·9859 | 8·20805 | 8· | 3· | 144 |
| 13 | 0·9790 | 8·15061 | 8· | 2· | 179 |
| 14 | 0·9722 | 8·09400 | 8· | 1· | 220 |
| 15 | 0·9655 | 8·03821 | 8· | 0· | 267½ |
| 16 | 0·9589 | 7·98326 | 7· | 15· | 320 |
| 17 | 0·9524 | 7·93445 | 7· | 14· | 379 |
| 18 | 0·9460 | 7·87587 | 7· | 14· | 6 |
| 19 | 0·9396 | 7·82258 | 7· | 13· | 70½ |
| 20 | 0·9333 | 7·77013 | 7· | 12· | 141 |
| 21 | 0·92715 | 7·71893 | 7· | 11· | 220 |
| 22 | 0·9210 | 7·66773 | 7· | 10· | 299 |
| 23 | 0·9150 | 7·61778 | 7· | 9· | 387 |
| 24 | 0·9091 | 7·56866 | 7· | 9· | 43 |
| 25 | 0·9032 | 7·51954 | 7· | 8· | 137 |
| 26 | 0·8974 | 7·47125 | 7· | 7· | 236 |
| 27 | 0·8917 | 7·42379 | 7· | 6· | 341½ |
| 28 | 0·8861 | 7·37717 | 7· | 6· | 15 |
| 29 | 0·8805 | 7·33055 | 7· | 5· | 126½ |
| 30 | 0·8750 | 7·28476 | 7· | 4· | 243½ |
| 31 | 0·8695 | 7·23897 | 7· | 3· | 360½ |
| 32 | 0·8641 | 7·19401 | 7· | 3· | 45½ |
| 33 | 0·8588 | 7·14989 | 7· | 2· | 174 |
| 34 | 0·8536 | 7·10660 | 7· | 1· | 308½ |
| 35 | 0·8484 | 7·06330 | 7· | 1· | 5½ |
| 36 | 0·8433 | 7·02084 | 7· | 0· | 146 |
| 37 | 0·8383 | 6·97922 | 6· | 15· | 292 |
| 38 | 0·8333 | 6·93759 | 6· | 15· | 0½ |
| 39 | 0·8284 | 6·89679 | 6· | 14· | 152½ |
| 40 | 0·8235 | 6·85600 | 6· | 13· | 304½ |
| 41 | 0·8187 | 6 81004 | 6· | 13· | 25 |
| 42 | 0·8139 | 6·77608 | 6· | 12· | 182½ |
| 43 | 0·8092 | 6·73695 | 6· | 11· | 346 |
| 44 | 0·8045 | 6·69782 | 6· | 11· | 72 |
| 45 | 0·7999 | 6·65952 | 6· | 10· | 241½ |
| 46 | 0·7954 | 6·62205 | 6· | 9· | 417 |
| 47 | 0·7909 | 6·58459 | 6· | 9· | 154½ |
| 48 | 0·7865 | 6·54796 | 6· | 8· | 335½ |
| 49 | 0·7821 | 6·51133 | 6· | 8· | 79½ |
| 50 | 0·7777 | 6·47469 | 6· | 7· | 260½ |
| 51 | 0·7734 | 6·43890 | 6· | 7· | 10 |
| 52 | 0·7692 | 6·40393 | 6· | 6· | 200½ |
| 53 | 0·7650 | 6·36896 | 6· | 5· | 395 |
| 54 | 0·7608 | 6·33399 | 6· | 5· | 150½ |
| 55 | 0·7567 | 6·29986 | 6· | 4· | 349 |
| 56 | 0·7526 | 6·26573 | 6· | 4· | 110 |
| 57 | 0·7486 | 6·23242 | 6· | 3· | 314½ |
| 58 | 0·7446 | 6·19912 | 6· | 3· | 81½ |
| 59 | 0·7407 | 6·16665 | 6· | 2· | 291½ |
| 60 | 0·7368 | 6·13418 | 6· | 2· | 64½ |
| 61 | 0·7329 | 6·10171 | 6· | 1· | 274½ |
| 62 | 0·7291 | 6·06925 | 6· | 1· | 47 |
| 63 | 0·7253 | 6·06384 | 6· | 0· | 269 |
| 64 | 0·7216 | 6·00764 | 6· | 0· | 531½ |
| 65 | 0·7179 | 5·97683 | 5· | 15· | 275½ |
| 66 | 0·7142 | 5·94603 | 5· | 15· | 57½ |
| 67 | 0·7106 | 5·91606 | 5· | 14· | 287½ |
| 68 | 0·7070 | 5·88609 | 5· | 14· | 77½ |
| 69 | 0·7035 | 5·85695 | 5· | 13· | 311 |
| 70 | 0·7000 | 5·82781 | 5· | 13· | 107 |
| 71 | 0·6965 | 5·79867 | 5· | 12· | 340½ |
| 72 | 0·6930 | 5·76953 | 5· | 12· | 136½ |
| 73 | 0·6896 | 5·74122 | 5· | 11· | 376 |
| 74 | 0·6863 | 5·71375 | 5· | 11· | 183½ |
| 75 | 0·6829 | 5·68544 | 5· | 10· | 423 |
| 76 | 0·6796 | 5·65797 | 5· | 10· | 231 |
| 77 | 0·6763 | 5·63050 | 5· | 10· | 38½ |
| 78 | 0·6731 | 5·60385 | 5· | 9· | 289½ |
| 79 | 0·6699 | 5·57721 | 5· | 9· | 103 |
| 80 | 0·6667 | 5·55057 | 5· | 8· | 354 |
| 81 | 0·6635 | 5·52393 | 5· | 8· | 167½ |
| 82 | 0·6604 | 5·49812 | 5· | 7· | 424½ |
| 83 | 0·6573 | 5·47231 | 5· | 7· | 233½ |
| 84 | 0·6542 | 5·44650 | 5· | 7· | 63 |
| 85 | 0·6512 | 5·42153 | 5· | 6· | 325½ |
| 86 | 0·6482 | 5·39655 | 5· | 6· | 151 |
| 87 | 0·6452 | 5·37157 | 5· | 5· | 413½ |
| 88 | 0·6422 | 5·34560 | 5· | 5· | 231½ |
| 89 | 0.6393 | 5·32245 | 5· | 5· | 69½ |
| 90 | 0·6364 | 5·29831 | 5· | 4· | 328 |
| 91 | 0·6335 | 5·27417 | 5· | 4· | 167 |
| 92 | 0·6306 | 5·25002 | 5· | 4· | 0 |
| 93 | 0·6278 | 5·22671 | 5· | 3· | 274½ |
| 94 | 0·6250 | 5·20339 | 5· | 3· | 111 |
| 95 | 0·6222 | 5·18009 | 5· | 2· | 385½ |
| 96 | 0·6194 | 5·15850 | 5· | 2· | 224½ |
| 97 | 0·6167 | 5·13430 | 5· | 2· | 65 |
| 98 | 0·6140 | 5·11182 | 5· | 1· | 345 |
| 99 | 0·6114 | 5·09017 | 5· | 1· | 193½ |
| 100 | 0·6087 | 5·06770 | 5· | 1· | ... |
| 101 | 0·6061 | 5·04605 | 5· | 0· | 322½ |
| 102 | 0·6035 | 5·02440 | 5· | 0· | 171 |
| 103 | 0·6009 | 5·00276 | 5· | 0· | 19½ |
| 104 | 0·5983 | 4·98111 | 4· | 15· | 305½ |

[The last two lines in the Table represent the paraffine homologue Butane, the lightest liquid body as yet discovered.]

[Continued from SUPPLEMENT, No. 941, page 15046.]

## ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

*Lectures I. and II.*

A NEW phase in the history of the measurement of high temperatures began with the work of Sir William Siemens, who showed that the variations in the electrical resistance of a heated metallic conductor would afford a pyrometric method. The names of Muller, Quincke, and Ressig may be mentioned in connection with early work in this direction, but Siemens was the first to demonstrate the practical nature of the method. The first notice I can find of his experiments is given in a letter to Dr. Tyndall, dated December, 1860. Twelve years later, in a lecture delivered before the members of the Royal Institution,† Siemens makes some interesting remarks on the industrial aspect of pyrometry as limited by capabilities of the mercurial thermometer. He said: "When we ascend the scale of intensity, we soon approach a point at which mercury boils, and from that point upward we are left without a reliable guide; and the result is, that we find in chemical books on chemical processes, statements to the effect that such and such a reaction takes place at a 'dull red,' such another at a 'bright red,' or a 'cherry red,' or a 'white heat,' expressions which remind one," he adds, "of the days of alchemy, rather than chemical science at the present day." With reference to this it may be observed that if, as Sir William says, technical men "were left without a reliable guide" directly the limits of the mercurial thermometer were passed, it was their own fault. The thermo-couples proposed by Becquerel and others would have given them trustworthy measurements of high temperature, but they either lacked knowledge of the sources of information or the skill to use the far from complicated appliances at command. An excellent dead-beat galvanometer, so essential in connection with all pyrometric methods of which electricity is the base, was long ago provided by Sturgeon, but metallurgists, who sadly needed a good pyrometer, were either ignorant of the existence of such physical instruments or untrained in their use, and are now only beginning to recognize the necessity for their adoption.

The nature of Siemens' instrument may be made clear by the accompanying diagram (Fig. 4). A divided current passes from the battery, B, to a platinum wire, C, coiled around a clay cylinder, and to a resistance coil, R. At the ordinary temperature, the resistance of the platinum coil is balanced by the standard resistance, R. If, however, the platinum coil be heated, the resistance, will be increased, and this increase of resistance which can be measured in various ways, indicates the temperature of the coil, C. The coil itself may be adequately protected and exposed to temperatures, which have been determined by the air thermometer; the deflection of a suitable (differential) galvanometer, G, will then indicate temperatures directly. For instance, the temperature at which zinc boils has been accurately fixed at 940° C., and if the coil is heated in the vapor of boiling zinc, the angle through which the galvanometer mirror is deflected marks the temperature of 940° C.

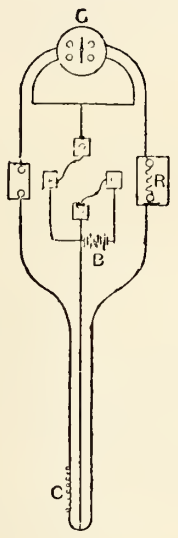


FIG. 4.

For many years this electrical resistance pyrometer was the only appliance believed to be trustworthy, which could be placed in the hands of artificers. Its usefulness was widely recognized, and a committee of the British Association was appointed to report upon it. The result of the inquiry* rather tended to shake confidence in the instrument, as it was shown that it was liable to changes of zero. Mr. H. L. Callendar† has, however, done admirable service by proving that, with certain precautions, the method may be rendered trustworthy. He winds the platinum wire on a plate of mica, excludes reducing gases, as the committee suggested, by inclosing the coil in a tube of doubly glazed porcelain, and uses a zero method of measuring the current with the galvanometer.

It will have been evident from what has been already adduced with reference to the works of the Becquerels and of Deville that by the year 1880 two main systems of pyrometry had been well established. These depended respectively on the use of the air thermometer and of thermo-couples. Siemens' electrical pyrometer, though its utility was admitted, was expensive, and confidence in it was not established. The basis of optical pyrometry had been firmly laid, but the measurement of high temperatures by optical methods had not passed into the domain of industrial work.

The publication of the article "Pyrometry," in the last edition of the "Encyclopedia Britannica," in 1886, enables us to judge what progress had been attained at the period when this important work appeared. In 1886, the author of that article, Mr. N. Shaw, who is so eminently qualified to form an opinion, took a distinctly gloomy view of pyrometry. He concludes his excellent article by suggesting doubt whether any of the instruments he describes "can be easily made to take up the temperature of the body or inclosure under investigation," and he says that "perhaps the most important modern attempts at the development of pyrometry are those connected with the identification of the law connecting the temperature with the amount and nature of energy which it radiates, for on such attempts depends the possibility of measuring the temperature of a hot body by means of the light it emits" . . . and he adds that "at present there is no general agreement between scientific men as to the form the relation takes." In 1886, the year Shaw wrote, the beginnings of very distinct advances in practical pyrometry were made. Callendar published the first part of the work that is subsequently developed in his well known paper,* which restored confidence in the electrical resistance pyrometer. In the following year Professor H. Le Chatelier† communicated a paper to the Chemical Society of Paris on the platinum, platinum-rhodium thermo-couple, which gave an entirely new and vigorous impulse to thermo-electric methods of pyrometry, as the form of thermo-couple he employed takes up the temperature of the locality in which it is placed with astonishing rapidity; and Barus established the thoroughly trustworthy character of the platinum, platinum-*iridium* couple, and devised a very ingenious pyrometric method depending on the viscosity of gases.

Fig. 5 represents, somewhat diagrammatically, the arrangement of Callendar's apparatus.‡ A B, B C, are equal resistances, forming the arms of the balance. The battery is connected at A and C, and one terminal of the galvanometer, G and B; D E represents a set of resistance coils, which, together with the resistances, A B and B C, may be supplied by an ordinary box of coils of the "post office" pattern. F K represents a straight bridge wire, with a divided scale attached. The other terminal of the galvanometer is connected to contact piece, H, which slides along this wire. The leads, A M, K N, from the pyrometer coil, P, are connected to A and K; and the compensating leads, C L, L D, the resistance of which is equal to A M, K N, are connected to C and D. These four leads may be of any convenient length; they are symmetrically arranged, so that corresponding parts are always at the same temperature. When the balance is found by inserting suitable resistances in the arm, D E, and sliding the contact piece, H, it is plain that, since the resistances, A B, B C, are equal, the resistance of the pyrometer and its leads, together with that of the length, H K, of the bridge wire, will be equal to the remaining portion, F H, of the bridge wire, together with the coils, D E, and the compensating wires, C L D. Thus, the changes of the resistance of the pyrometer leads, A M, K N, are compensated by the equal changes in the leads, C L, L D, and the resistance of the pyrometer coil itself is directly given by the sum of the coils, D E, and the reading of the bridge wire. The resistance of a centimeter of the bridge wire, F K, is made to correspond to such an increase of the resistance of the pyrometer coil, P, as is produced by a rise of 1° C. The contact key, H, slides along this wire, and the galvanometer can easily be made sensitive to one-hundredth of a centimeter of this bridge wire; so that one-tenth of a centimeter, which corresponds to one-tenth of a degree, can, of course, be measured with certainty. The author has worked for several days at the Royal Mint with Mr. Callendar, and is satisfied that, at temperatures exceeding that of bright redness, the comparative readings are accurate to one-tenth of a degree. This would have been considered impossible a few years ago, and the statement will, perhaps, be received with some incredulity. Later on, evidence will be examined which leads to the belief that, in the measurement of a "white heat," degrees of value similar to those of the ordinary mercurial thermometer are still employed.

The reader will, however, remember that measuring the increased resistance of a heated conductor is not the only way in which electricity has been made serviceable in the measurement of high temperatures. It has long been known that if the junction of two metals be heated, the electrical equilibrium of the system is disturbed, and the measurement of the difference of potential produced affords a means of estimating the temperature of the junction. The use of such thermo-junctions appears, as has already been stated, to have been suggested by A. C. Becquerel in

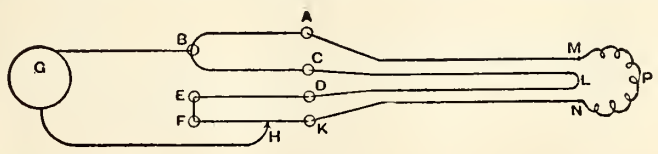


FIG 5

1826, and adopted by Pouillet ten years later. Unfortunately, the metals composing the thermo-junctions were badly chosen, and their use was consequently greatly retarded until, as already stated, within the last few years, Professor H. Le Chatelier, of Paris, advocated the use of platinum, in conjunction with platinum alloyed with ten per cent. of rhodium. The author first adopted this couple in 1889, and has since constantly used it, in conjunction with a photographic recorder, devised for the purposes of an investigation which was entrusted to him by the Institution of Mechanical Engineers. This instrument will be described presently. In its latest form, the couple consists of two wires, one of platinum and the other of platinum-rhodium alloy, mentioned above, simply twisted at their ends or soldered with gold, and connected with a dead-beat galvanometer of about 200 ohms resistance. The Deprez and D'Arsonval form of galvanometer, particularly the latest type of this instrument, is admirably adapted for use with the thermo-couple.

A photographic method was employed as early as 1887 by H. Le Chatelier§ in connection with his thermo-couple. It consisted in allowing the image of induction sparks, produced at regular intervals of time, to fall on a narrow fixed sensitized strip of glass. If the temperature to which the thermo-couple is exposed is rising or falling at a uniform rate, the photographic images of the sparks will be equidistant, but if there is at any moment an arrest in the rise, or fall, of the temperature, the images of the sparks will then be

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† "Pro. Roy. Inst.," vol. vi., p. 483.

* "British Association Report," 1874, p. 242.

† "Phil. Trans Royal Soc.," vol. clxxviii., 1887, p. 161, and subsequent papers in the "Phil. Mag." and "Proc. Roy. Soc."

* "Phil. Trans. Roy. Soc.," loc. cit.

† "Bull. Soc. Chim." Paris, vol. xlvii., 1887, p. 2; "Journal de Physique," vol. vi., 1887, p. 23.

‡ "Phil. Magazine," vol. xxxii., 1891, p. 104, and vol. xxxiii., 1892, p. 220.

§ "Comptes Rendus," vol. cxiv., 1887, p. 1443.

closer together. The distance between the individual lines affords a method for measuring the rate at which a thermo-couple receives or loses heat from any hot locality or substance in which it may be placed.

The new departure in pyrometry, by which curves are automatically obtained, will now be described. It will be obvious that by confining the image of the mirror to a minute spot, and by moving the sensitized plate at a uniform rate, a time-temperature curve may be traced by the aid of photography. Such curves are often very beautiful, and I have elsewhere shown* that they may yield results of much importance.

The arrangement, which is shown in Fig. 6, consists

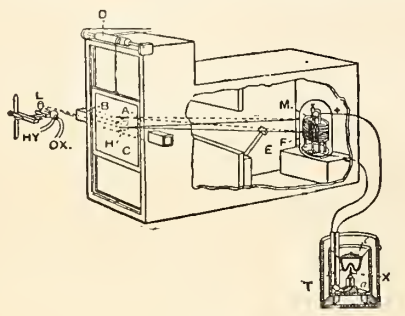



FIG. 6.

of a galvanometer of the Deprez and D'Arsonval type inclosed in a large camera; a fixed mirror, F, is placed below the movable mirror, M, of the galvanometer, so that the light from the lime cylinder, L, reflected in the mirror, H, passes to both mirrors, F and M, and is reflected in the direction of a fine horizontal slit, A B; behind which a sensitized photographic plate, C, is drawn vertically past the slit, by means of gearing, D, driven by clockwork. The ray from the fixed mirror is interrupted periodically by the vane, E, and a beaded datum line is given, which enables any irregularity in the advance of the plate to be detected.

The amount of divergence, from its datum line, of the spot of light reflected by the movable mirror at any given moment bears a relation (which can readily be found by calibration) to the temperature to which the thermo-junction, X, is heated; and the variations of temperature will be indicated by a curve, which is the resultant of the upward movement of the plate and the horizontal movement of the spot of light. A crucible, *c*, which may be filled with molten metal, is provided with a tubulure, T, for the insertion of the thermo-junction. The crucible is suspended by wires in a double jacket of tin plate, *a*, *b*.

The author is satisfied that this thermo-junction can afford trustworthy results, accurate to 1°, at temperatures of over 1,000° Centigrade. One important feature of the appliance is the minuteness of the space occupied by the thermo-junction, which may be suitably protected, and inserted into the midst of a very small mass of metal. The pyrometer is calibrated by exposing the thermo-junction to certain known temperatures, such as the solidifying points of salts or metals. There is no difficulty in recognizing the melting or solidifying points; for, as the mass passes from the solid to the fluid state, the temperature remains constant for a brief period, the duration of which depends on the amount of material operated upon, and its latent heat of fusion; the result being that the spot of light from the galvanometer will be arrested, and the position on the scale at which it stops marks the temperature to be determined. A detailed drawing of a more elaborate form of this appliance is given in Fig. 7.

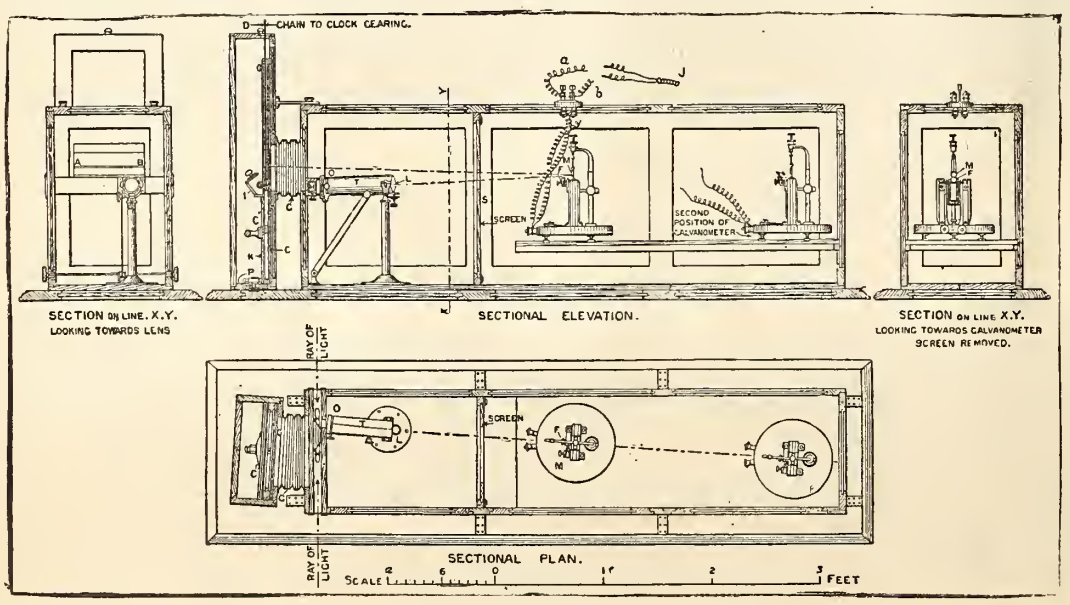



FIG. 7.

The appliance consists, as is shown in the accompanying plate, of a camera about five feet long, in which a galvanometer may be placed in either of two positions, according to the range of temperature to be observed. This camera has three doors, and is made separate from the portion of the apparatus which contains the moving photographic plate, C. The two parts are connected by a flexible leather "bellows" junction, G, the object being to enable the plane of the sensitized plate to be adjusted at right angles to the rays of light from the galvanometer mirrors, F and M. Inside the camera is a focusing tube, T, containing a lens, L, which receives the light from the mirror, H, and transmits it to the mirrors, F and M. One of these mirrors, M, is movable, and is carried by the coil of the galvanometer; while the other, F, is carried upon an adjustable arm fixed to the supports of the galvanometer, its function being to send a ray of light from the mirror, H, to the slit, A B, and thus to trace a datum line as the photographic plate travels upward. The temperature is recorded by the variations in the position of the spot of light received from the mirror, M. There is a screen, S, to cut off light reflected from the brass work of the galvanometer. The end of the tube, T, is provided with an adjustable brass slit, O, by means of which the width of the photographic traces on the plate may be varied. The mirror, H, is mounted on a block, which can be adjusted so that external light may be received from either side.

The focusing of the lens, L, may be effected from outside the camera. Plug connections are provided for at the top of the instrument, and the wires, *a*, *b*, connect the galvanometer with a thermo-couple, J, placed in the furnace or other source of heat. The photographic plate is secured to its carrying slide, C', by means of little cams; and this carrier is inclosed in a case, K, provided with a light-tight door, I. The case, K, is held in position by a pin, P. The connection of the photographic plate with the driving clock is shown at D. It may be mentioned that the galvanometer stands on three plates, which provide the well known combination of the hole, slot, and plane, to insure steadiness. If the sensitized plate be replaced by a revolving drum bearing photographic paper, it will be obvious that a time temperature curve of considerable length can be readily obtained; and such curves afford convenient records of the variations in the temperature of any furnace, or other source of heat, in which the thermo-couple, J, may have been placed.

*(To be continued.)*

* "Proceedings Roy. Soc.," vol. xlix., 1891, p. 347; vol. l., 1892, p. 367. "Proceedings Institute of Mechanical Engineers," 1891, p. 543, and 1893, p. 102.

## NOTE ON AN ABNORMAL MELTING POINT.

By E. J. BEVAN, F.I.C.

IN the course of an examination of a crystalline fatty body obtained from pure lard by fractional crystallization from ether, I had occasion to determine its melting point. For this purpose capillary tubes were filled with the melted body in the usual way. The melting point, determined within a few minutes of filling the tube, was 47° C. Another tube, filled at the same time, but examined the next day, gave a melting point of 61·5°. This tube, after allowing the body to solidify, was plunged into water at 50°, and, to my great surprise, was found to melt instantly to a perfectly clear fluid. The experiment was repeated at intervals down to a temperature of 45·5°, at which point it remained solid. A number of experiments were made on a larger scale, using test tubes internally coated. After standing twenty-four hours, the substance remained solid, when the tube was plunged into water at 50°. One-half of the contents of the tube was then melted over a burner and allowed to solidify.

On plunging the tube into water at 50° it was found that the portion recently heated melted to a clear liquid, the remainder being quite solid and opaque; and the portion melted corresponded exactly with the part of the tube heated.

It is clear, therefore, that the body has two very definite and widely different melting points, and that it passes slowly and spontaneously from the state of low melting point to that of the higher, and can be made to pass from the high to the lower state immediately by simple heating.

As I hope to show you, it can also be made to pass from the lower to the higher state by gradually increasing the temperature.

Thus, I take a tube recently heated and place it in water at about 43°. At this temperature it remains solid; on gradually raising the temperature, I find that the substance melts to a clear liquid at about 47°. If now the temperature be still further gradually increased, the substance passes again into the solid state at about 53°, and does not melt again till a temperature of about 62° is reached.

The existence of the two melting points was confirmed by the use of Cross and Bevan's method, as described in the *Chem. Soc. Jour.* for 1882.

These experiments emphasize the importance, which has before been insisted on, of delaying the determination of melting points for some hours after the substance has been melted.

It has since been pointed out to me by Mr. Allen that some curious experiments by Mr. T. Maltby Clague on the alteration of the melting point of cocoa butter are recorded on page 570 of his *Commercial Organic Analysis*, vol. iii., part ii.

The chairman (Mr. Otto Hehner) remarked that the subject was very important. Analysts often met with such difficulties in analyzing fatty substances. It would be very desirable to come to some agreement as to the conditions under which the melting point of a fat ought to be taken.—*The Analyst, December*, 1893.

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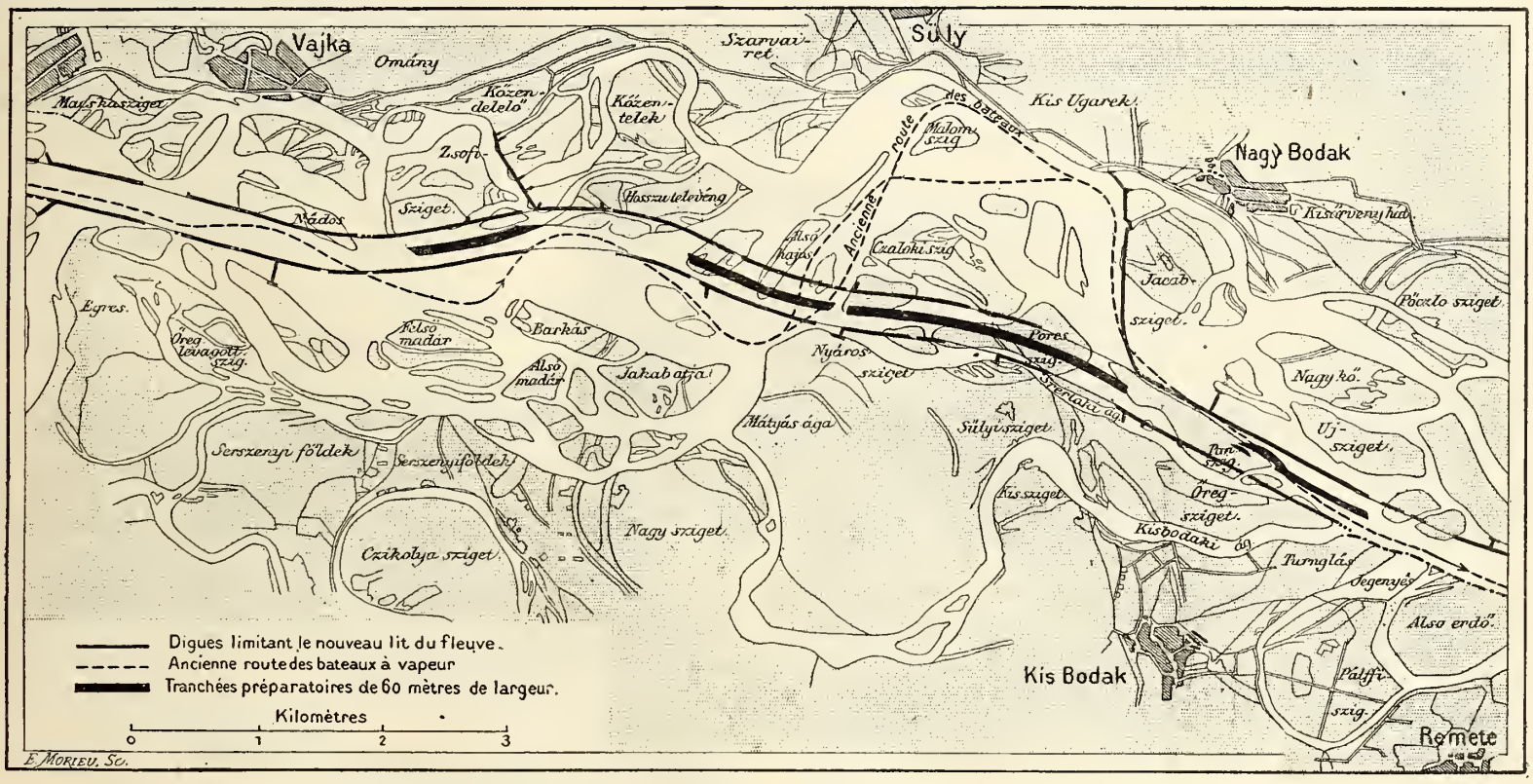
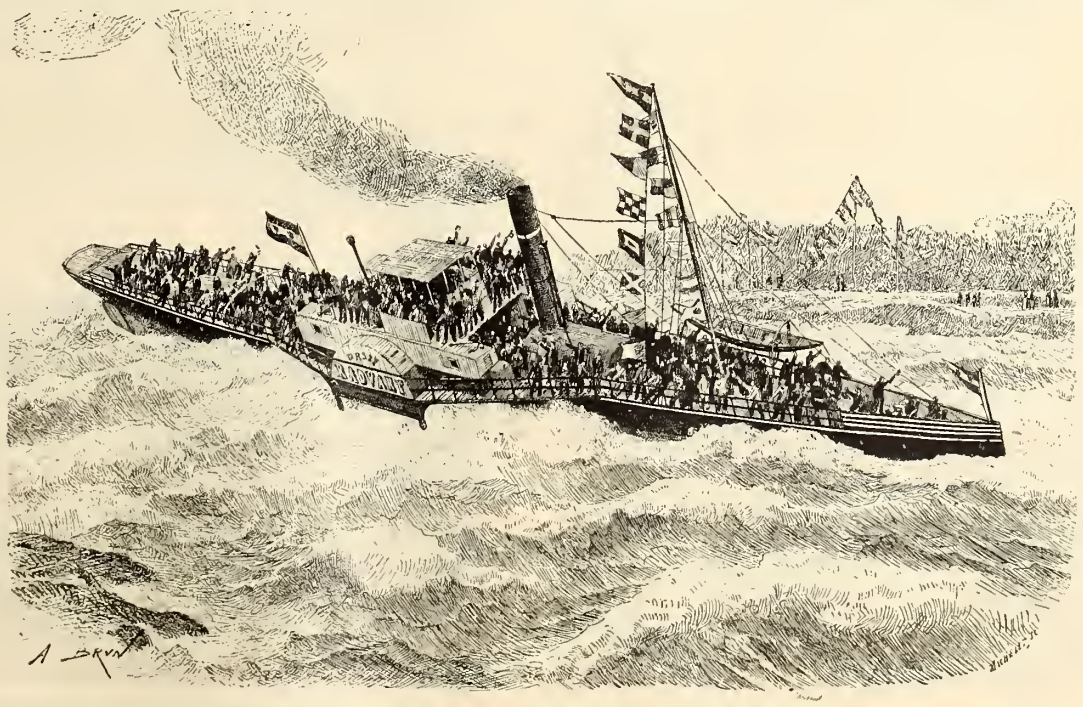
## THE WORK OF IMPROVING THE DANUBE.

SOME years ago the Hungarian government undertook a series of methodical operations with the object in view of rendering the course of the Danube regular. There are two reasons that served as a motive for this work. In the first place, it is of interest to facilitate navigation upon this beautiful river, which, merely in the part traversing Hungary, has a length of 575 miles. Now, the sinuosities of its channel, which in addition to being constantly shifting, expose ships to incessant detours and sometimes to delays or stranding. In the second place, from time immemorial, the Danube has exposed the regions through which it passes to terrible inundations, some of which have left painful remembrances. We shall not speak at present of the important work on the celebrated channel of the Danube called the "Iron Gates." The object of this work, recently begun and actively prosecuted, is to free the bed of the river of a very hard rocky barrier that obstructed it. This is a special and isolated case of the general programme. The works that we shall speak of to-day, and the different episodes of which are shown in our engravings, consist in diking the river and giving it a uniform and invariable width of 300 meters. Moreover, the too pronounced bends that are met with are intersected by the channel so as to shorten the way for navigation in avoiding the sinuosities resulting from them. Of course, the engineers profit by this occasion to dredge the bed of the river to a uniform depth and to render its slope regular. It was necessary to divide the putting in execution of this important work into several sections. The first credit of 34,000,000 francs, voted by the Chambers, was devoted to rendering regular that part of the river comprised between the frontier of Austria and the market town of Deveny and of Duna-Radvany, at 11 miles below Komorn. In this section the Danube has a length of 87 miles. The work of straightening this part, comprised between miles 7·75 and 75·5 of the general plan, was begun in the spring of 1886. It is now nearly finished. The 300 meter channel has been diked, dredged and fixed. Moreover, eight bends of the river have been cut off at points where they presented an exaggerated development or where, as shown in our engraving of the part inaugurated on the 22d of October last, they traversed a true meander of small canals surrounding innumerable islands or islets. The excavation of the channel at Jarfalu was one of the most difficult phases of the operation. It was accomplished with remarkable precision through the use of methods new and original in the art of public works. We shall enter into a few details on the subject of them. As our map shows, the engineers utilized, as far as possible, the course of the Danube itself in their direction line, which, by the rational study of curves and gradients, recalls that of a great railroad line. When they had to deal with the principal arm of the river, they narrowed it to the adopted width of 300 meters by diking it in its very course. If there was a question of utilizing a small arm, it was widened through dredging. Finally, where the direction line required it, in order to preserve the regular and methodical velocity, the engineers boldly cut through the islands, fields and forests. The construction of the dikes presented no peculiarity except their unusual length. They were executed by the ordinary processes of earthwork wherever the ground presented no special difficulties. On the contrary, a very original process was brought into play for widening the arms of the river utilized, but having an insufficient width, and for the cutting off of the bends having a great inflexion. With remarkable sagacity, the engineers made the Danube itself not only render its new bed regular and deepen it, but also fill in the dikes established in order to render it regular. This method, of which the various phases are represented in our engravings, is as follows: Let us place ourselves in the case where there is reason for prolonging the channel by widening a small arm partially utilized and rectifying the projections of the banks. To this effect, the dikes are in the first place prolonged in the alignment indicated by the plan, as well upon *terra firma* as in the bed of the river when one meets it, or else are raised to two meters in height with a width of two meters upon *terra firma* solely after it has been cleared of trees. The future bed of the river is thus traced upon the land and diked. It remains to deepen it and clear it of everything that might obstruct it. By means of strong dams above the section, all the secondary arms, aside from the one utilized, are blocked up, and the entire discharge of the river is forced to pass through the narrowed section of the new channel. There results a strong current, owing to which the water, by its very live force, deepens the bed, removes the projections of the banks and, in a word, accomplishes with rare power and rapidity a work that by the usual processes of dredging or earthwork would be at once lengthy, costly and troublesome. The excavation thus effected by the river is not accomplished, of course, without quite a large portion of the dry stones of which the dikes are constructed being torn away. These stones simply fall to the bottom of the talus that forms the banks of the new channel and constitute a sort of rockwork there that assures the stability of them. The engineers, therefore, have on the whole, merely to slightly complete the construction of the dikes and stop up a few holes, after the




MAP OF THE CANALIZATION OF THE DANUBE, BETWEEN VAIKA AND REMETE.

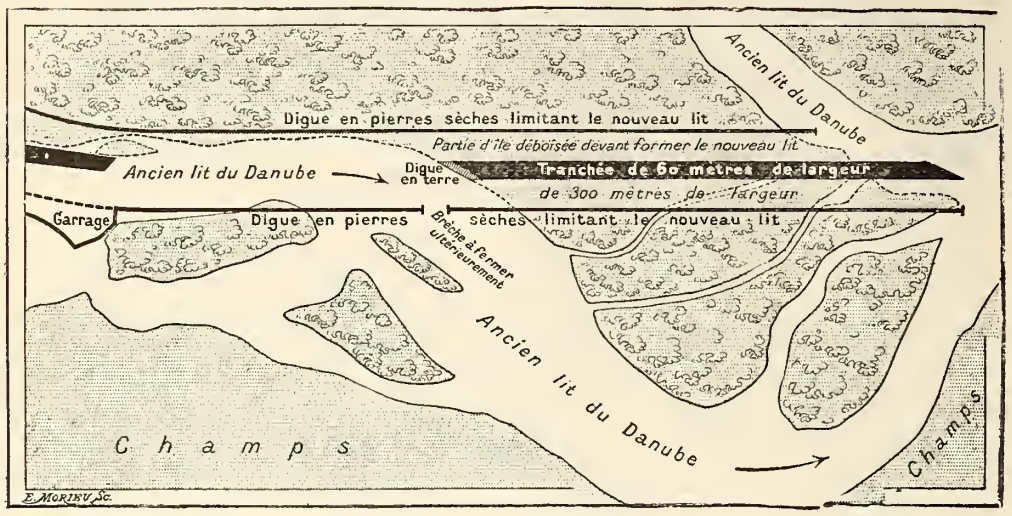


THE STEAMBOAT RADVANY ENTERING THE NEW BED OF THE DANUBE.

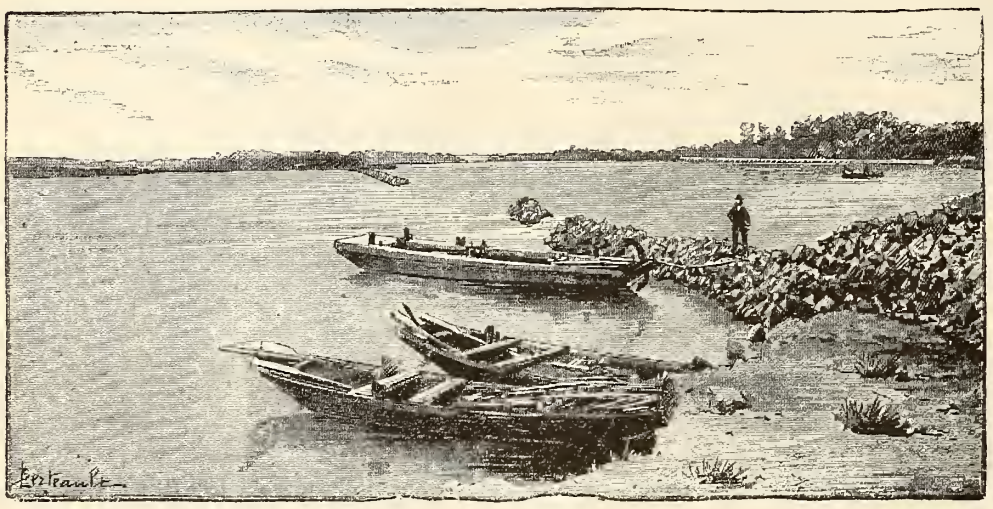
powerful current, which serves them as a colaborer, has accomplished its work.

As for the earth, sand and mud that the current carries along, and which might obstruct the river bed upon depositing, there is opened to them here and there sired point the materials that it has torn away in the first place in order to open up and deepen its new channel.

We have said that one of the most curious episodes of this great work was the cutting of the pass of Jar-


Ancien lit du Danube
Digue en pierres sèches limitant le nouveau lit
Partie d'île déboisée devant former le nouveau lit
Ancien lit du Danube
Digue en terre
Tranchée de 60 mètres de largeur
de 300 mètres de largeur
Garrage
Digue en pierres sèches limitant le nouveau lit
Brèche à fermer ultérieurement
Ancien lit du Danube
C h a m p s
Champs
E. MORIEU Sc.

THE PART OF THE WORK INAUGURATED OCTOBER 22, 1893.



ONE OF THE LONGITUDINAL DIKES OF DRY STONES.

downstream a sort of gate from 50 to 100 meters in width in the dike. These breaches correspond to the small condemned arms. The muddy stream flows into these, deposits therein and fills them up. The Danube has thus completed its work by depositing at the defalu, at 1¾ miles above Presbourg. The abolishing of the bends was begun, in fact, in starting from the lower extremity. That of Jarfalu bore the number 8. At this place the river ramifies into a host of small arms, through which navigation had to pick its way.

Moreover, it presented a sill upon which, during severe winters, blocks of ice became frequently piled. The water, arrested in its course, rose behind this obstacle and flowed back toward Presbourg and threatened its security. The straightening effected will do away with such inconveniences and dangers. At the place indicated, the old bed of the Danube, the principal arm, has a width of about 700 meters and describes an irregular arc of a circle, the chord of which is sensibly figured by the new channel, 1,960 meters in length. The grade in the old bed is 39 centimeters to the kilometer. The new channel will have a grade of 67 centimeters to the kilometer, thus giving between the two extremities of the Jarfalu section a change of level of 1·33 meters.

For such straightening, as we have already stated, the Danube itself was utilized. Here is how: The new channel traversed in its passage a wooded island that it was necessary to cut into for a width of 300 meters. A beginning was made by clearing this island of trees, etc., over this entire width. Then, as shown in our engraving, the earth was removed to a depth of one meter over a width of 60 meters in the alignment. Afterward, the water was allowed to enter, and the floating dredger deepened the channel to two meters below the zero of the scale.

An approach was thus made to within 22 meters of the old bed of the Danube, which was separated from its new bed by a sort of natural dam remaining in the island. There was nothing further to do but to allow it to tear away this barrier and finish the work of the engineers. This operation gave rise to an imposing solemnity.

The high society of Presbourg was invited on the 22d of last October, by the direction of the enterprise, to see the Danube take possession of its new bed. Royal Councilor Alexander de Keczkes, of Ganocz, presided at the ceremony, assisted by M. Banlaky, engineer in chief.

As shown in our engravings, a tongue of land separated the majestic Danube, all inflated with its force, from the cutting that was to guide its route in the conquest of its new domain. At ten minutes past eleven, M. Banlaky gave the signal by removing a shovelful of earth. A force of laborers, spade in hand, made a trench in the dams established in the island and which closed the four cuttings made from one side to the other.

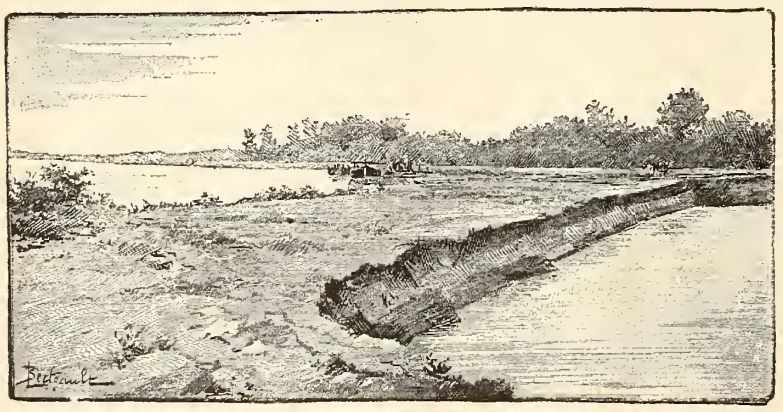
At a quarter past eleven thin streams of water began to infilter through the dams. At half past eleven the frail barrier was broken. Small cause, great effect! In a few minutes, the Danube, quickened, found its way. A muddy stream flowed from each of the little cuttings, and the first rowboat was able to effect its passage between the old bed of the Danube and the new channel. And the island that barred the route was seen to be washed away and disappear under the torrential action that kept ever increasing.

At ten minutes of one, one of the islets isolated by the trenches, the most friable islet, had disappeared. On board the steamboat, the passengers saluted jovially, in drinking the excellent wines of Hungary, the breaking away of the natural dam.

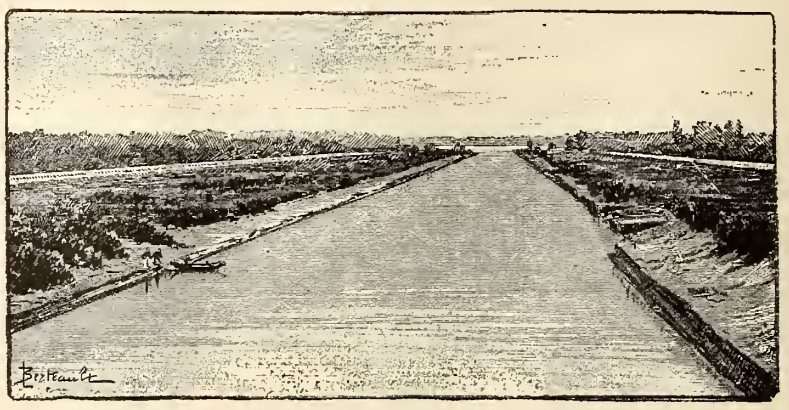
The Danube, as if proud of its work and impatient to finish it, tore away and devoured everything that resisted it.

At forty minutes past one nothing remained intact except the last islet. This the river attacked and undermined, and at ten minutes past two it had disappeared.

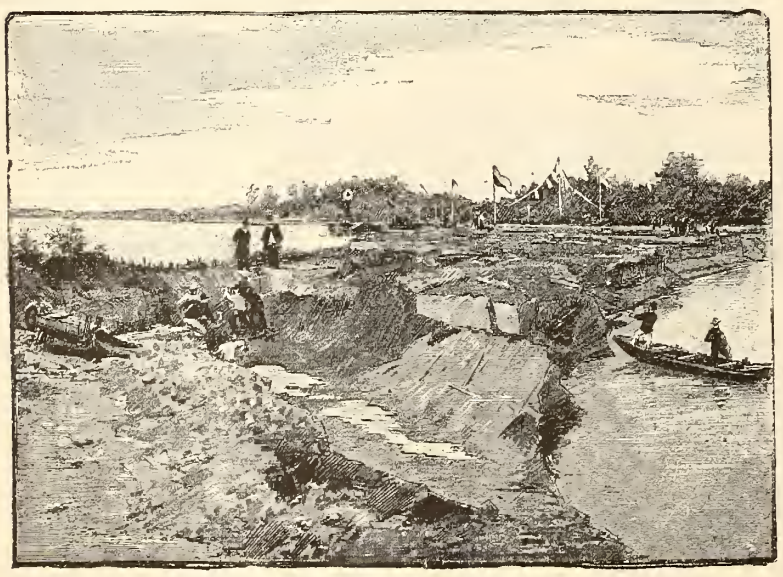
Upon the spot where the island was that morning



DAM SEPARATING THE PROVISIONAL CUTTING FROM THE PRINCIPAL BED OF THE RIVER.



PROVISIONAL CUTTING OF THE NEW BED OF THE DANUBE.



THE FIRST INFILTRATIONS.

THE PASSAGE OF THE FIRST ROWBOAT.

rooted in the earth there was now a rapid nearly two meters in depth, forming a formidable current, effecting in a few minutes what could not be done by an excellent dredger in a day.

The engineers had promised themselves to triumph to the end. With a confidence in themselves that did them honor, at twenty minutes past two, three hours after the first blow of the pick given by M. Banlaky, they permitted the steamer Radvany to blow her whistle, merrily leave her mooring and intrepidly cross the rapids to enter victoriously into the new channel. . . .

At the hour at which we write, the Danube is automatically pursuing its work. The width of the new bed that it is increasing, deepening and shaping at the will of its power already exceeds 100 meters. During this time one is proceeding with the finishing of the dikes and necessary works; but steamboats and lighters can now pass without impediment by the direct route.—*L'Illustration.*

## ARTESIAN WELLS AS A SOURCE OF WATER SUPPLY.*

By Prof. ERASTUS G. SMITH.

A GIFTED and usually very sensible writer on the manufacture of paper has written one very senseless sentence: "Boring an artesian well in an untried place is like digging for hidden treasure, a very uncertain undertaking." I indorse the writer's sentiment if by it we are to understand a random, happy-go-lucky, hit-or-miss style of boring and exploration, with no chart or compass to give the proper bearings, trusting that we may hit something somewhere below in the depths of Mother Earth, and that smiling Fortune will crown our misguided efforts. Capital so invested and energy so misdirected usually reap the just harvest of their own reckless seeding. But it can hardly be affirmed at the present time that the study of the deep artesian well service is a new field of investigation, or that data are wanting regarding it which may not be of rich service in properly determining the course of action over a good share of our territory, or lend their value and assistance in pushing such ventures to a rational and successful conclusion.

The term "artesian well" has unhappily become somewhat confusing. Strictly speaking, it should be applied only to such deep wells as are bored through impervious rock strata to a porous water-bearing rock stratum, whence the water flows to the surface and is discharged from the bore. The term has come into very wide use, and has been applied to many classes of wells, even some of the shallower pipe wells merely driven a few feet into sand and gravel being very improperly called "artesian wells." It is almost necessary, however, to retain the use of the term "artesian" for such very deep wells as pierce impervious strata to free porous water-bearing strata, whence the waters rise to within a short distance of the surface, even if there may be no real flow established. Such a well is an artesian well to all intents and purposes, and as such I think it fair to include in our discussion. The study of these artesian wells is a legitimate and necessary field of study for the hydraulic engineer, as at so many points at the present are they under consideration as a source of water supply for public service. This study includes two quite separate and distinct fields—the purely geological study and the purely chemical study.

The first of these divisions I shall pass over at this time, as the full explanation of these conditions lies in the geological field, and the engineer who would intelligently approach the study and who would expect to successfully and economically develop a deep artesian well at any locality with credit to himself and the complete satisfaction of his patrons, must avail himself of the services of the geologist who may in his judgment be most familiar with the topography and stratigraphy of the particular region. The particular conditions must be thoroughly studied on the ground and made as intelligible as possible by a mastery of the general conditions controlling artesian wells. I would like to refer members of this association to an article on "The Requisites and Qualifying Conditions of Artesian Wells," in the fifth annual report of the U. S. Geological Survey, written by Prof. Thomas C. Chamberlain, which is probably the most succinct and clear exposition of these general conditions; also to an article by the same author in "Geology of Wisconsin," Vol. I. The first article especially should be on every hydraulic engineer's shelf for ready reference. Every student of water supply is more or less conversant with the principles involved, but in order that we may have definitely in mind just these principles of artesian wells to make more clear what I may say a little further on, I will simply allude to the conditions controlling an artesian flow, allowing you to fill in the details as your individual study and experience may suggest.

### ESSENTIAL GEOLOGICAL CONDITIONS OF ARTESIAN WELLS.

The artesian well has its source, its downward underground course, and its ascent through the well. Picture to your mind a pervious stratum through which water can readily pass. Below this let there be a water-tight bed and a similar one above. Suppose these layers come to the surface in some elevated region, and then pitch downward in some direction to considerable depth, and then come up again at some distance, thus forming a great basin, or else terminate in such a manner that water cannot escape in that direction. Now let rainfall and surface waters fill this porous stratum full to the brim. It is evident that if this stratum full of water and under head be tapped at any lower level, the water will rise in the bore and be discharged from the opening, this continuing so long as supply will equal the demand of the bore. Or to formulate distinct propositions from this simple conception, the essential requisites are: A porous stratum to receive and permit the passage of the water; an impervious stratum below to prevent escape of the water downward; a like impervious stratum above to prevent the escape of the water from the bed upward; an inclination of the strata, so that the edge where water enters may be higher than at the surface of the well and give the head; a suitable exposure of the edge, preferably with a covering of porous sand or gravel, to form a collecting area sufficient for the supply of water; an adequate rainfall to furnish this supply, and an absence of any escape for the water at a lower level than the surface of the well. Without going further into the general conditions or the details affecting them and thus controlling the supply, this annunciation of the simple geological principles will serve to fix this class of well distinctly in mind.

### SOME CHEMICAL FEATURES OF ARTESIAN WELL SUPPLY.

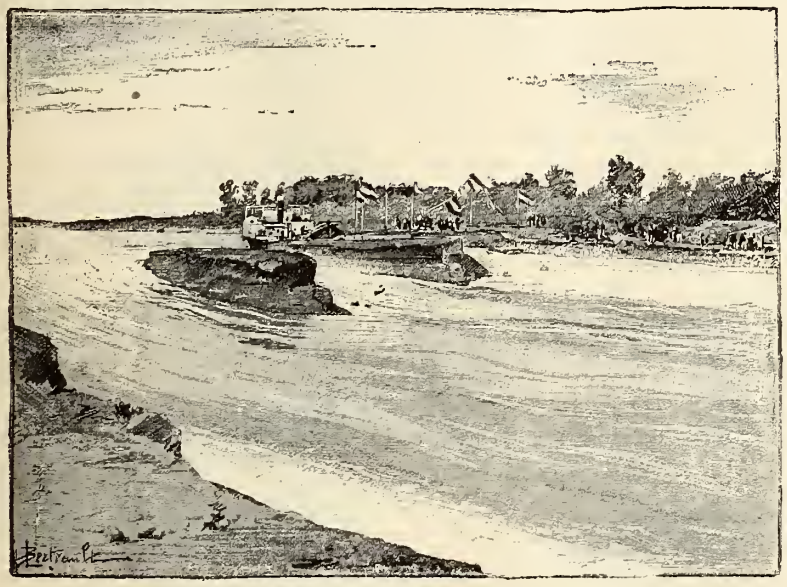
This is distinctively the chemical side of the problem of artesian wells. The quality of a water is the gravest question for the consulting engineer to adjust in his determination regarding the best available local supply for a public system. The term pure water is fast disappearing from the specifications of engineers and guarantees of franchises. Experience has taught us not to guarantee the impossible, and a pure natural water is an impossibility. It is counter to all theories and expectations that we shall find such a commodity as pure water. It may be good and wholesome, but never pure. Our artesian source does not differ in the least in this respect from our surface waters. In fact, we may almost say that many troubles we meet with in surface waters are in artesian wells doubly intensified. I think we may lay it down as a general principle that we may expect in artesian water a great increase in saline matters over our ordinary land waters for the same locality. There are some notable exceptions, one of which will be noted further, but as a general rule I have found our deep artesian well waters heavily loaded with saline matters. If any of my hearers have had occasion to canvass thoroughly the advisability of our artesian supply at any point, and in connection with that study may have collected any considerable number of chemical analyses of waters from deep artesian wells, he has I am sure been perplexed and bewildered by the returns received, until in despair at hope of securing any intelligent data which would be of use in determining the problem in hand, the whole undertaking may have been abandoned.

This confusion regarding the quality of water from artesian wells arises from our imperfect knowledge of the strata whence the flow comes. The analysis may be perfectly true and may give us a true knowledge of the quality of the water the well furnished and be of great value to all parties; but as an indication of what we may find elsewhere or as an index of the quality of water we may expect in that section, it is worthless, because we do not know the strata whence the flow is established. It is absolutely essential in using such data intelligently that we have the complete record of the well; its depth, the strata traversed, their thickness, the water-bearing strata, their relative thickness, abundance of flow and quality of same, before we can rightly use that well as an index for other borings. And yet in how many wells is any such record kept? We know the depth of the well, the character of the final flow, and little else. You can see at once the significance of this condition. A thin layer of limited extent containing saline matter is traversed; this is mingled with the main stream coming from below, and imparts a distinctively saline character to the whole. This localization of saline strata produces most confusing results—*e. g.*, an artesian well in Illinois, 1,300 feet deep, the water from which submitted to me gave 88 grains of solids to the gallon. A well 7 miles away and 2,100 feet deep gave 31 grains to the gallon or, roughly speaking, only one-third as much. Well No. 1 is useless, well No. 2 fair.

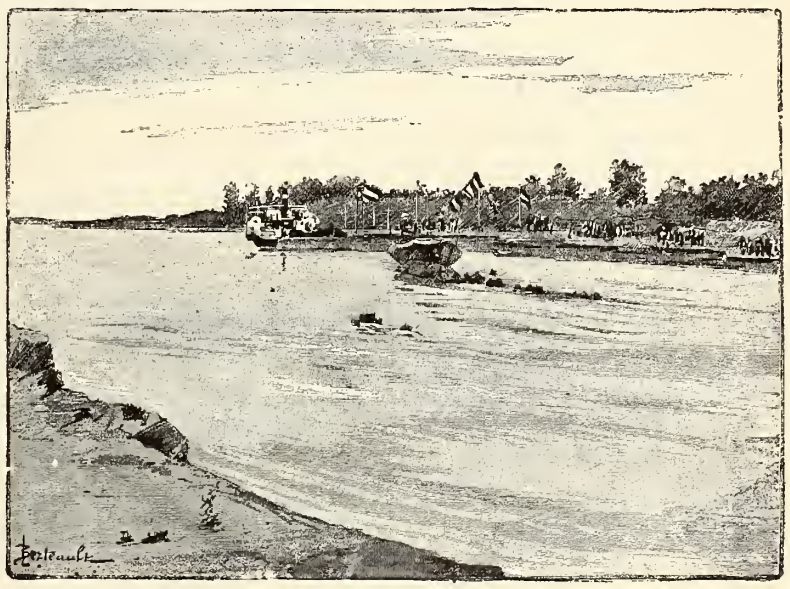
The confusion arises also because thus an attempt is made to compare waters from absolutely different strata, and therefore of probably radically different character. Waters from the same strata, however far remote the wells may be, are usually of essentially the same character. This is what we must expect from the very conditions of artesian wells, and what is well defined conformity is the case. Marked deviations are, I am sure from observation of the waters discharged, due to infiltration from other strata insufficiently cut off and plugged back. The practical side of this consideration should not be lost sight of by this convention. It is safe to assume that when water from one stratum has been proved to be good that elsewhere we may expect the same quality of water, if only we may be able to strike into the same stratum and then sufficiently protect that stratum from degrading infiltration from other strata traversed above.

It seems to me that we can make this whole matter very clear if we can follow one series of artesian wells somewhat in detail. The whole Mississippi basin furnishes us with the very best examples of artesian service in this country. Other localities give also a good artesian service, and many other wells furnish an adequate and good quality of water. Among the very best defined artesian wells of the Mississippi basin are those springing from the Potsdam sandstone. If you will recall the conditions for an artesian well, you will find them very typically illustrated in this layer and a most splendid field for the intelligent study of the whole problem.

The Potsdam sandstone crops out in Wisconsin, its lower edge being around Portage, about 30 miles north of Madison, and running in an irregular crescent shape across the State. Its greatest width is about 50 miles, and the area covered is upward of 12,000 square miles. The stratum then dips somewhat to the east of south, passing under southern Wisconsin and reaching to unknown distances south. This bed is upward of 1,000 feet in thickness. In texture it is a loose, porous sandstone with thin beds of shale and limestone irregularly traversing it. The confining impervious stratum above is the magnesum limestone, the Potsdam resting directly upon the old archæan and granitic formations. The exposed edge of the Potsdam in Wisconsin is channeled and furrowed by watercourses, and is overlaid



THE DISAPPEARANCE OF ONE OF THE ISLETS.



THE DEBRIS OF THE LAST ISLET.

| LOCALITY. | Date. | Depth. | Potassium Sulphate. | Sodium Sulphate. | Sodium Chloride. | Sodium Phosphate. | Sodium Bicarbonate. | Magnesium Bicarbonate. | Calcium Bicarbonate. | Calcium Sulphate. | Iron Bicarbonate. | Alumina. | Silica. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Madison, Wis | .... | 1,015 feet. | 0·024 | 0·29 | 0·219 | Trace. | 1 09 | 12·98 | 15·24 | . | 0·021 | Trace. | 0·42 | 30·76 |
| Janesville, Wis | 1887 | .... | 0·116 | 0·408 | 0·489 | " | .... | 12·664 | 12·045 | 0·314 | 0 087 | 0·093 | 0·536 | 26·75 |
| Whitewater, Wis | 1889 | 957 feet. | 0·14 | .... | 0·86 | " | ... | 11·58 | 14·57 | 0·53 | 0 16 | 0·04 | 0·47 | 28·35 |
| Burlington, Wis | 1889 | 1,008 " | 0·56 | 1·08 | 0·46 | " | .... | 8·89 | 12·10 | 2·46 | 0·03 | 0·03 | 0·40 | 26·01 |
| Rockford, Ill. Well No. 1 | 1885 | 1,530 " | 0·52 | 0·52 | 0·36 | " | .... | 12·79 | 13·18 | .... | 0 07 | 0·05 | 0·62 | 28·11 |
| Rockford, Ill. Well No. 2 | 1886 | 1,320 " | 0·52 | 0·31 | 0·34 | " | 0·41 | 12·85 | 13 15 | .... | 0·09 | 0·10 | 0·05 | 28·82 |
| Rockford, Ill. Well No. 3 | 1886 | 1,996 " | 0·50 | 0·35 | 0·27 | " | 0·81 | 12·79 | 13·17 | .... | 0·07 | 0·13 | 0·58 | 28 67 |
| Dixon, Ill | 1889 | 1,600 " | 0·07 | 0·75 | 0·27 | " | .... | 12·16 | 14·04 | 0·17 | 0·07 | 0·09 | 0 77 | 28·39 |
| Sterling, Ill | 1886 | 1,450 " | 0·46 | 0·54 | 0·69 | " | .... | 13·35 | 14·85 | .... | 0·06 | 0·06 | 0·61 | 30·64 |

* A paper read before the American Water Works Association at Milwaukee, Wis., September, 1893.

with a more or less thick layer of drift sand and gravel. The very ideals for an artesian service are thus realized; the broad, spongy collecting area, the downward inclination of strata, the confining impervious beds, the porous, sandy, transmitting stratum. All geological conditions indicate a probable flow at points where the level of the orifice of the well is sufficiently below the level of the collecting area in Wisconsin. What is the quality of the water and how may the data be used in studying other prospective supplies for this great region above the Potsdam sandstone?

The source of the water supply is primarily the rainfall on the collecting area. This water thus originally essentially a pure water will contain such mineral salts in solution only as the waters may meet and traverse in their course downward through the superficial drift and the deep strata. I can fortunately offer for your study nine full analyses of waters from the Potsdam sandstone, concerning the integrity of which I have absolutely no question as being true Potsdam waters, and efficiently cut off from infiltration from other strata. It will be noticed that these wells are in an almost straight line north and south and follow essentially the dip of the sandstone. All of these analyses, with the exception of the first one, were made by myself at different periods.

In addition to the above table, I can add the following data regarding these Potsdam waters, when only partial analyses were made the solids being given in totals merely:

| Locality. | Depth. | Date. | Total Grains per Gallon. |
|---|---|---|---|
| Rockford, Ill., Well No. 4 . | 1,300 feet | 1891 | 17 |
| From five wells combined.. | 1,530 " | 1891 | |
| " " " " | 1,320 " | | |
| " " " " | 1,996 " | | 19·3 |
| " " " " | 1,300 " | 1891 | 20·0 |
| " " " " | 1,379 " | 1891 | 20·0 |
| Graham's Mill..... | 1,400 " | 1891 | 17·8 |
| Princeton, Ill..... .. | 2,500 " | | 23·7 |
| Belvidere, Ill... ..... .. | 1,932 " | | 16·7 |

I will not add to this list of analyses in this connection, as it seems to me perfectly clear from these already given that the waters yielded by this stratum at different periods and from different levels are practically uniform in character. This is what we should expect, as it is quite counter to the theory and practice of solution that draughts from different points of the same reservoir should give a fluid of essentially different constitution.

The second general principle regarding the waters from artesian wells can, I think, also be best understood by a special case, and for this purpose I will again take the Potsdam sandstone. It seems safe to assume that we may regard about 28 to 30 grains of solids calculated as in above table as the normal constitution of true Potsdam water. But other waters represented as coming from Potsdam sandstone give quite other results, of which I will cite a few typical cases, from analyses collected from various miscellaneous sources, but not verified by the analyst or check analyses.

| Locality. | Depth. | Total. | Alkalies, Sulphates, Chlorides, and Carbonates. |
|---|---|---|---|
| Woodstock, Ill ... ... | 1,300 feet. | 39·9 | 15·09 |
| Monmouth, Ill ... ... | 1,227 " | 73·8 | 42·62 |
| Rock Island, Ill..... .. | 1,100 " | 67·3 | 51·0 |
| Davenport, Ia ..... | 2,150 " | 60·1 | 38·0 |
| Clinton, Ia ..... | 1,674 " | 38·8 | 18·0 |
| Kenosha, Wis .. .... | 1,365 " | 36·02 | 12·2 |

Many others might be given, some of them with even greater differences than these, but what I wish to call especial attention to is this: That the Potsdam water contains normally about 28 to 30 grains per gallon of water, of which only about 1·0 to 2·5 grains are the soluble salts of the alkalies, *i. e.*, the sulphates, chlorides, and carbonates of potash and soda, leaving roughly about 26 grains of the other mineral matters, mostly the bicarbonates of lime and magnesia. In these cases cited there is a marked increase in solids, but that increase is due to an increase of the soluble alkaline salts. The carbonates of lime and magnesia are usually somewhat diminished, being changed into the corresponding sulphate. To explain and account for these deviations we are therefore forced to one of two conclusions—either the data furnished by some analyses are incorrect or waters from some points of the Potsdam sandstone are subject to local variations. The first conclusion we will dismiss here, as many of the analyses are by men of acknowledged skill and reputation in the analysis of waters.

The second perplexing proposition finds its answer, it seems to me from my study of these wells, that while the water from the sandstone is true Potsdam, it has been materially altered by infiltration from the superincumbent strata which the drill has traversed and the infiltrations from which have not been sufficiently cut off or plugged back. I am not sure that this view will meet with the unqualified indorsement of all present, but it seems to me perfectly reasonable and to meet the case. In support of this view, I would note that in drilling a well it is well known that many smaller water-bearing strata are traversed. None of them probably may come to the surface, but the waters would seep out and work out into the bore. When the head of the Potsdam strata was pierced and a flow established, we cannot expect that the water rushing up the bore would by its own momentum plug back completely all superior infiltrations, but that rather they would be borne along with the water. Admit this principle once, and deviations in our Postdam supply are explained.

When the essential features for a true artesian flowing well are recalled, conditions can be conceived where such superior filtrations would be improbable, *e. g.*, where in such superior strata their pressures and textures are such that the waters from the Potsdam under greater pressure find a partial escape along them. But in many true flowing wells it can be conceived how this infiltration would be perfectly true, and especially is it true for the great number of deep wells called artesian and used for a supply included also under this discussion, when waters do not rise fully to the surface, but are pumped. It is further a matter of common experience to those studying the artesian supply that wells are thus frequently plugged either above or below a given stratum, thus cutting off undesirable waters and improving the quality. And finally we note that as we go further south and southwest on the Potsdam supply the waters become more and more saline in character, or as we approach the coal districts the alkalies and the sulphates become more permanent.

I have dwelt thus at length upon the Potsdam sandstone supply, because, in the first place, I was personally more familiar with it, and secondly, because it has been so carefully studied that I deemed it the best method in which to clearly present to this body the principles underlying the study of wells and the laws of probabilities controlling them. We might repeat this study with good results in the great stratum known as the St. Peter's sandstone, and would arrive at very similar conclusions. Apply the study to general true artesian supply, and we will find the trouble and perplexity greatly diminished if we search diligently for the true strata water and distinguish carefully between it and the foreign infiltration. A second source of perplexity in our study will be removed if we do not confound our true artesian service where waters flow or rise under head in the bore with simple bored wells, or, worse than all, mere drift-driven wells; in both latter cases we are dealing with quiescent waters, non-comparable with those from the deeper strata and under head. With these last two classes of waters this paper does not deal.

While it is true our sandstones furnish our best artesian supply, and their study essentially covers the study of the artesian service in the Mississippi basin, flowing wells are occasionally obtained from other strata and even from the drift. The characters of the waters then partake of the character of the matrix—in the case of a limestone becoming more heavily charged with lime and magnesia, and in the case of drift becoming merely a modified surface water.

As compared with surface waters, it will usually be found true that the deep artesian waters are more heavily loaded with saline matter. We do not expect to find an artesian water with much under 30 grains of solids per United States gallon (with lime and magnesia calculated as bicarbonates). About the same amount fairly represents our best surface waters. Rivers and streams contain less and the lakes least of all, Lake Superior heading the list with two to three grains of solids per gallon of water. In artesian wells the dissolved solids rise rapidly to amounts giving the waters a distinctly saline taste and forbidding their use for a general supply. For other sections of the country others must speak authoritatively. Some analyses made at the Beloit laboratory from artesian wells along the Gulf of Mexico would indicate that there the waters are feebly alkaline and are superior to even our best artesian waters. Analyses from artesian wells at other points are too sporadic to justify us in drawing at present conclusions therefrom.

There is one other important feature regarding the constitution of deep artesian waters to which I would call the attention of this convention, and this is by the significance of a sanitary analysis of water as applied to these deep artesian wells. There is no competent engineer or water works manager but has an idea in a general way regarding the data furnished by a sanitary analysis of water. This aims to give such data as may lead to some accurate conclusions regarding the presence and amounts of organic matters in water and the consequent healthfulness or unhealthfulness of a supply. The data usually required are the volatile residue, fixed residue, total residue, hardness, chlorine, oxygen consumed after various intervals, and especially the condition of the nitrogen as shown by the albuminoid ammonia, free ammonia, nitrous and nitric acids. One unanswerable argument in favor of artesian wells hitherto advanced has been their positive freedom from organic and surface waters and sewage. The very conditions for an artesian well—deep, impervious, superimposed strata—seem to favor the idea. In the actual demonstrations to prove the presence or abseuce of organic matters, the methods of the sanitary analysis of surface waters have been quite widely applied. There may be no objection to this study of the waters, but I am sure that we will be led into serious error in formulating an opinion, unless extreme care is taken regarding the correct interpretations to be given to such analyses. I have made several such whole or partial sanitary analyses of artesian waters, and have collected some made by others from these wells. These almost, without exception, fall into one of two classes. Those where the data are reduced to almost zero in each determination, and therefore show the absence of organic matters; those where the analyses show some astounding amounts in one determination, notably in the amount of free ammonia.

In the first class are found our free Potsdam sandstone waters, and probably our St. Peter's sandstone waters, leaving little to be desired in the matter of purity, according to accepted standards, and with this word may therefore be dismissed. It is the second class I wish to call special attention to at this time, as the results obtained are so abnormal, and reports based on these data have been made regarding such wells positively condemning them. So far as I know, the literature of the analyses of water supplies is silent on these particular conditions, save an occasional fugitive allusion, merely citing the fact of the presence of a large amount of ammonia.

In a paper read before the American Association for the Advancement of Science, at Madison, last summer, on "The Occurrence and Distribution of Nitrogen in Deep Artesian Wells," I called the attention to those peculiar conditions and phenomena and will introduce one table used at that discussion. The analyst or hydraulic engineer who may have had much experience with these deep wells will have noticed the extraordinary amounts of free ammonia some of them show; in fact, so much that our ordinary methods of estimating it are almost worthless. But as significant is the fact that while the free ammonia is so high, nitrogen in all other conditions, as albuminoid ammonia, nitrous acid, and nitric acid, is wanting. This is quite contrary to what we would expect or do find almost without exception in surface waters. To make more clear this peculiar condition of the nitrogen, I will make ten such analyses of waters from the artesian wells made at the Beloit Laboratory which are selected as well illustrating the phenomena:

| Locality. | Depth. | Total Solids Grains Per U. S. Gallon. | Free Ammonia. | Albuminoid Ammonia. | Nitrogen as Nitrites. | Nitrogen as Nitrates. |
|---|---|---|---|---|---|---|
| Whitewater, Wis..... | 315 | 16·7 | 0·15 | 0·01 | 0·00 | 0·00 |
| Massillon, O..... | 303 | 15·4 | 0·45 | 0·01 | 0 00 | 0·00 |
| Chicago, Ill..... ..... | 400 | 13·6 | 0·26 | 0·07 | 0·00 | 0·00 |
| Van Wert, O.... .... ..... | 53 | 93·5 | 0·52 | 0 03 | 0·00 | 0 00 |
| Van Wert, O..... | 98 | 93·9 | 0 59 | 0 02 | 0·00 | 0 00 |
| La Grange, Ill..... | 2,100 | 31·6 | 0·40 | 0·05 | 0 00 | 0·00 |
| Peru, Ill.... . .... ..... | 1,360 | 49·5 | 1·08 | 0·05 | 0 00 | 0 00 |
| Hillsboro, Ill..... .... | 400 | 39·1 | 1 20 | 0 01 | 0·00 | 0·00 |
| Harvey, Ill..... .... ..... | 1,300 | 88·0 | 0·90 | 0 00 | 0·00 | 0·00 |
| Davenport, Iowa.... .... ..... | 1.067 | 73·2 | 0·90 | 0·01 | 0·00 | 0·00 |

The study of this table develops some noteworthy observations. The enormous amounts of free ammonia; the trace of albuminoid ammonia so low as to suggest whether it really is not accidental or free ammonia, only expelled after the addition of the strong alkaline permanganate solution added to develop the albuminoid ammonia; the absence of nitrites and nitrates. The presence of any such amount of free ammonia in any such surface water would be viewed with grave suspicion, if not positively condemned, and application of these same standards to the artesian wells might lead to condemnation.

It is to be specially noted, however, that we have the nitrogen all aggregated into the one form of ammonia and not distributed through the four forms usually met with, and I think it becomes remarkable and attracts attention, because thus aggregated into the single form and not distributed through the four forms. A simple calculation of the nitrogen changed into and distributed through these usual forms would show it to fall well within our accepted standards for maximum impurity of waters.

The fact of so much ammonia so often found in these deep waters, its significance and cause, were to me for a long time a source of perplexity and anxiety on being required to pass a correct opinion on their sanitary nature. The samples had been very carefully collected in my own glass-stoppered bottles; thoroughly cleaned before leaving the laboratory and protected from intruding ammonia on return. Duplicate well-checking analyses from different bottles proved that the amount of ammonia truly represented the ammonia normally present in the water. A chance visit to one of the wells revealed the presence in traces of sulphureted hydrogen and suggested a reasonable explanation of the difficulty. Personal inspection of seven of the wells in the above table expressly to determine this point, and correspondence regarding all others containing high ammonia coming under my observation have shown the presence of this sulphureted hydrogen in the waters. So that the extraordinary ammonia can be explained on the basis that the sulphureted hydrogen has exerted its well-known reducing action, either reducing the higher oxidized compounds of nitrogen back to ammonia or preventing entirely their formation. This explanation seems to me perfectly satisfactory and reasonable. It may be that other agencies, as the iron oxide dissolved in these waters, also lend their assistance to the final result, but probably the sulphureted hydrogen is the principal one at work.

On this basis of explanation it is fair to question whether any amount of ammonia up to 1. + per million at least has any significance for these deep wells. This is the practical point I wished to develop to this body of practical men. You can see at once how our ordinary standards of maximum impurity (*e. g.*, 0·08 free ammonia per million) utterly fail when applied to any such data as are cited above. The above explanation has satisfactorily met all cases comiug thus far under my observation, and it will be a matter of great interest to see whether it may coincide with the experience of others and may sufficiently meet future inquiries and developments.

Regarding the gases present in these deep artesian wells, I would note the carbonic acid gas almost always present in the free state, and by virtue of which the carbonate of lime and magnesia are held in solution. Oxygen, according to the eminent analyst, Dr. Brown, of Boston, is always absent in these deep wells. Sulphureted hydrogen is very often present. It is, however, very elusive and disappears rapidly and wholly on relief of the waters from pressure and on aeration. In none of the analyses quoted above had I any suspicion of the presence of the gas when they reached the laboratory, and other analyses of artesian waters rarely make references to it.

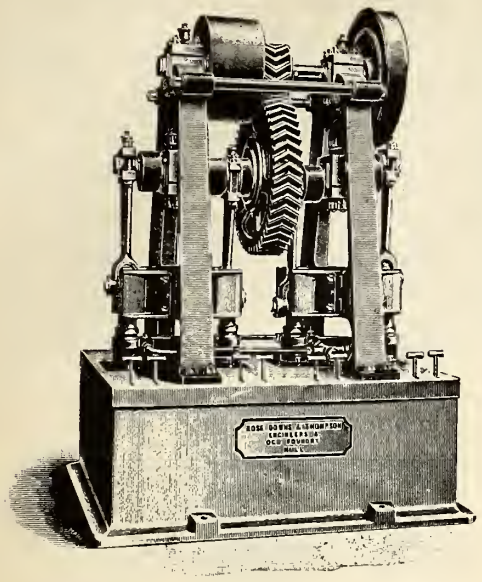
In conclusion, then, to briefly sum up some observations on these artesian wells, I would note:

1. The distinctively geological study and the distinctively chemical study it is necessary to give the problem in arriving at intelligent conclusions before advising or attempting developing an artesian service for a public water supply. 2. The confusion and perplexity which exist on collocating and comparing results of analyses of waters from other artesian wells, and attempts to intelligently and profitably use them. 3. The fact that waters from a given stratum are presumably of a practically uniform character. 4. That waters from such strata are materially altered by infiltrations from superincumbent or inferior strata. 5. In the application to the deep artesian wells of the method of sanitary analysis, as usually employed for classifying and properly valuing surface waters, care must be taken in the interpretation of results to arrive at correct views and knowledge regarding them.

These five points have been definitely in mind during the preparation of this paper, not that in any sense they exhaust the study of the water supply from our deep artesian wells, but with the hope they may form a distinct contribution to the resources of and may throw additional light upon one of the difficult problems of the engineer.

## OIL MILLS OF THE BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY COMPANY.

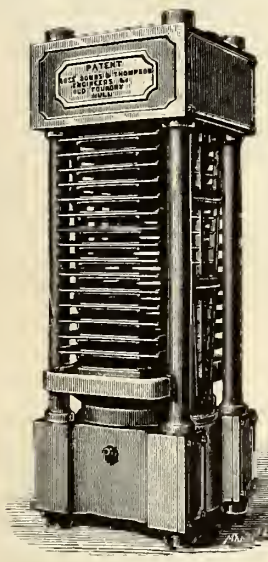
IN January, 1890, the directors of the Bombay, Baroda, and Central India Railway Company determined to erect oil mills to supply the large quantity of lubricating and illuminating oil used on the 461 miles of the



QUADRUPLE HYDRAULIC PUMPS.

line now open. By the advice of Sir A. M. Rendel, K.C.M.G., the design of Messrs. Rose, Downs & Thompson, of the Old Foundry, Hull—subject to some modifications suggested by Mr. E. B. Carroll, the company's locomotive inspector—was accepted.

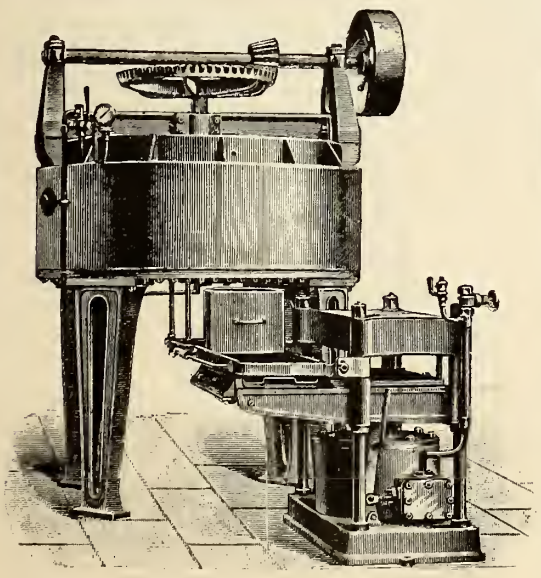
It was determined to erect the mills at Sabarmati, the transship junction between the broad gauge of the Bombay, Baroda, and Central India Railway Company and the narrow gauge of the Rajpootana-Malwa Rail-



HYDRAULIC OIL PRESS FOR 16 CAKES.

way, a convenient position on the company's system, and in a district well supplied with castor oil seed.

The process employed will be easily understood. The seed is delivered by rail to the mill premises, and stored in a go-down. The seed is conveyed in bags by a 15 in. gauge tramway to the sack lift, which raises it to a bin on the upper floor of the mill; from this it falls through a spout to the decorticator, a slide in the spout practically regulating the output of the mill, and its action



KETTLE AND SEED MOULDING AND MEASURING MACHINE.

is as follows: The thin, dark husk of the castor seed is cracked and separated, and the white kernel is used for the mill; the husk forms an excellent fuel.

The castor seed kernels are then pressed by the Anglo-American process as follows: The ground seed having been heated to about 100° Fah. in the kettle where it is damped and agitated, is withdrawn in charges by the moulding machine, where it is formed, measured, and given a preliminary compression. The "mould" of seed, now covered with a strip of woolen bagging, is placed in one of the presses. Each of these presses takes sixteen "moulds" of seed, and has a steel cylinder working at a pressure of 1½ tons per square inch. Under the first pressure about three-quarters of the oil is taken from the charge of each press. The cakes of compressed seed from these presses are then placed beneath the edge stones and reduced to meal, which is placed in an elevator by which it is put in a second kettle; from this it is withdrawn moulded and pressed in another block of presses. The hydraulic pressure for the presses and moulding machines is given by a set of quadruple belt-driven pumps, having four 3 in. low-pressure pumps, and the same number of high-pressure pumps 1⅛ in diameter.

These pumps, which work a pair of accumulators, are fitted with automatic safety relief valves. The expressed oil is lifted from the tanks beneath the presses by the pumps, and is subsequently clarified by boiling. The oil is conveyed to the various stations on the line by tank cars, those on the Malwa-Rajpootana taking five tons, and those on the Bombay, Baroda, and Central India 10 tons at a charge. The castor seed husk is used for fuel and the cake for manure for sugar cane crops. The mill is also fitted for crushing linseed, a large quantity of this oil being required for the company's paint works.—*The Engineer.*

## THE MANUFACTURE OF CIDER BY DIFFUSION.

LIKE all agricultural industries, that of the manufacture of cider has been notably improved within a few years. The *materiel*, the mills, the process, etc., have been so combined as to increase the produce and simplify the work. In even the most unpretentious cider manufactories hydraulic presses have been utilized. But a new method, very different from pressing, seems to be about to replace the extraction of apple juice in mills in Normandy and Picardy, and this is the method of diffusion, which has the advantage of giving a better and clearer cider and in larger quantity and also of easier preservation.

This method of diffusion consists in treating the cut or bruised fruit with water. The sugar and soluble principles pass by endosmosis through the walls of the vegetable cells, while the albuminoid substances remain undissolved in the cells. Upon the whole, the exhaustion of the valuable principles of the fruit is effected by water, and there is obtained a juice that is

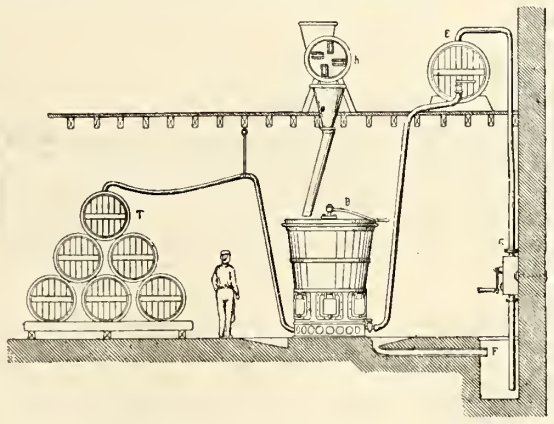


FIG. 1.—INSTALLATION OF A CIDER MILL DIFFUSER.

as dense as if it had been extracted through pressure and that is less alterable.

In the old method, the pressure, in breaking the cells, causes the albumen to pass into the juice and this favors those secondary fermentations that are observed in cider, and that so unpleasantly alter the bouquet of it.

This method of diffusion, moreover, is already substituted for the method of rasping and pressing in the extraction of beet root sugar, and has given most remarkable results.

The diffusion apparatus for the preparation of cider differ but slightly from those employed for the manufacture of sugar; it is always the methodical exhaustion by water of the fruit bruised or cut into thin slices. Cold water is employed. Warm water exhausts better and more quickly, but affords a juice incapable of furnishing a savory cider.

We shall describe one of the diffusion apparatus most employed, that of Laforet. It consists of a battery of six metallic diffusers of cylindrical form movable around an axis actuated by a lever (Fig. 2). Each diffuser is provided with a door for the reception of the sliced apples. At the base there is a door for the removal of the exhausted fruit. A tube leads the water into one of the diffusers, and, thanks to a rotary motion of the battery, the water can enter into any one of the diffusers. Of the six diffusers, five communicate with each other, while the sixth is isolated and is empty or full during the operation, which must be continuous.

Through a second tube communicating with the fifth diffuser, the water charged with the apple juice, and which constitutes the wort, is capable of escaping into the casks in which the fermentation takes place, that is to say, the transformation of the cider.

The diffusers being charged, one introduces the water, which, having passed into the five compartments, reaches the exhaust tube with a density of from 1·040 to 1·045 for a velocity of flow of two quarts per minute with apples of medium saccharine richness. After a quantity of juice equivalent to the capacity of a diffuser has passed the apparatus is revolved, when the first diffuser will be put out of communication with the current of water. The sixth diffuser, containing fresh apples, will be put in battery, and will be the one through which the juice will make its exit, the second diffuser serving for the introduction of the water. The first diffuser is then to be discharged, and, if the operation has proceeded well, it should contain merely pure water and exhausted apples. The rotary motion is then continued, and, as far as possible, uninterruptedly day and night.

The juice, left to fermentation or mixed with cider barm (as one is beginning to prepare it in order to improve its quality), ferments well. The rackings leave little waste, and, moreover, owing to the absence of albumen, no lees form in the casks, as in the case of cider obtained by pressure.

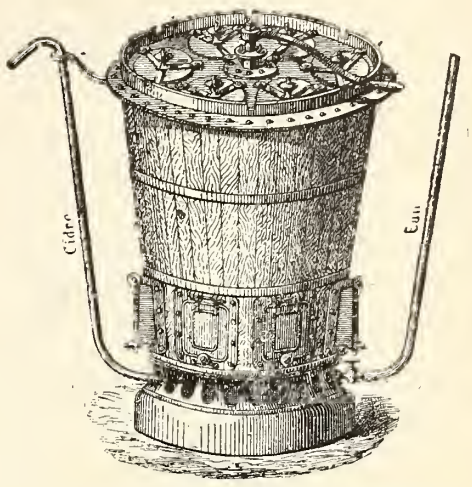



FIG. 2.—A CIDER MILL DIFFUSER.

The product in cider of a density of 1·040 is about one pint to a pound of apples. In a large cider manufactory where this process is employed, the hydraulic press formerly used in the same works gave a product of but ninety per cent.

The method of diffusion may be applied upon a small scale, and the management of the apparatus is easy and practical.

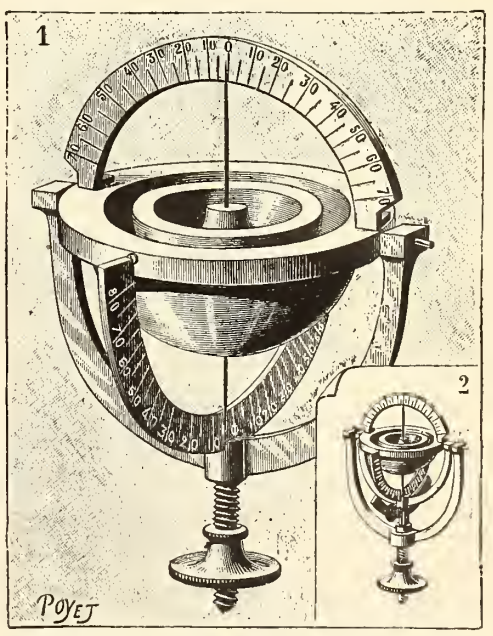
Fig. 1 shows an installation with an apple cutter, *h*, and battery. The water, lifted from F by a pump, G, and discharged into a feed cask, E, circulates in the battery, B, and, converted into wort, enters the fermenting tuns, T.—*La Science Moderne.*

## DOUBLE LEVEL WITH NEEDLES.

THE art of leveling, which, in our epoch, finds a more and more frequent application on account of the great works that the progress of science and the modern industries causes to be undertaken every day, necessitates instruments of which the rapid putting in place is in nowise prejudicial to the accuracy of the observations. The different instruments employed at present in geodesy have for base the spirit level, and all the operations tend toward the obtaining of a line parallel with the horizon.

The accompanying figure represents a level different from those constructed up to the present, and in which the horizontal line, entirely conventional and impossible to realize, is replaced by the vertical, the direction of which is absolute. This result is obtained by a new application of the principle of the Cardan suspension. In fact, up to the present, the Cardan suspension has been utilized only for maintaining in a fixed plane, vertical or horizontal, any object whatever (barometer, binnacle, compass, etc.), despite the oscillations of the external support. This mode of suspension consists, as well known, of two concentric circles, each suspended by pivots at right angles in pairs.

On the contrary, the apparatus under consideration utilizes the proper motions of the circles, which are replaced in the present case by small concentric hemispheres suspended also by pivots at right angles in pairs. The needles, one of them fixed to the center of




DOUBLE LEVEL WITH NEEDLES.

the internal hemisphere, and pointing upward, and the other to the summit of the external hemisphere, and pointing downward, indicate upon graduated semicircles, properly arranged in two planes at right angles with each other, by how many degrees the object that supports the level deviates from the

vertical, and starting from the horizontal, from front to back and from right to left. The graduation of the semicircles starts from the center, so that perfect horizontality is obtained when the two needles mark zero.

The distinctive character of this level is to fix, by a single motion, the horizontality of a plane by bringing the two right angle directions of the apparatus simultaneously at right angles with the vertical, while that with ordinary levels this operation requires two successive motions of the instrument, without counting the regulation of the bubble, which is always so lengthy and tiresome an operation, and always imperfect.

This little apparatus can be usefully applied to instruments of geodesy, surveying, leveling, tracing routes, etc., the putting in place of which will thus be effected with precision and sureness without changing the direction of the telescope.

At the lower right hand corner of the engraving is represented an application of the needle level, to which has been added a graduated sector placed beneath the lower semicircle and in the same plane. This sector, which is held by a binding screw, permits of giving the system as a whole any desired inclination, so that by the aid of this level it is possible to obtain a determinate gradient. Combined with an ordinary telescope, it would thus constitute a clisimeter, a clitograph or clinometer of high precision.

Placed upon any astronomical telescope provided with a reticule, the level thus completed at once makes an eclimeter of it. In fact, the upper needle indicates the zenith; the lower needle assures the horizontality of the perpendicular to the axis of the telescope; and the lower graduated sector, left free by the loosening of the screw designed to hold it, takes a position that shows, through a fixed datum point, how many degrees or fractions of a degree separate the zenith from the position of the star.

With slight modifications, artillerists might use it for the practice of firing. In any case, by means of this apparatus, one ought to reach a much greater precision than with the spirit level, since it determines the vertical in every direction through a single point—the extremity of each of the needles.

We think that this apparatus is susceptible of many other applications, and we have thought it of interest to make it known to the readers of *La Nature*.

## STUDIES OF THE PHENOMENA OF SIMULTANEOUS CONTRAST COLOR; AND ON A PHOTOMETER FOR MEASURING THE INTENSITIES OF LIGHTS OF DIFFERENT COLORS.*

By ALFRED M. MAYER.

IT is often desirable in the study of simultaneous contrast colors to have large surfaces colored by contrast, so that we can the better match the colors of these surfaces with rotating colored disks and thus arrive at quantitative statements of their hues. This is especially desirable in ascertaining the hues of the light of flames, of the Welsbach incandescent lamp and of the arc electric light when compared with daylight, or when compared one with another. The result of many experiments is the apparatus described in the following section, and which is useful for this purpose.

*Screen for ascertaining the hues of lights and the contrast colors of these lights.*—A ring is formed of white cardboard by cutting out a central opening of 12 cm. in diameter in a disk of 22 cm. in diameter. This ring has a breadth of 5 cm. Another ring is made similar to this one, except that it has four narrow radial arms to support a disk of thin translucent *white* paper,† 35 cm. in diameter. This paper disk is placed between the rings, which are then fastened together and screwed to a thin rod, on a stand as shown in Fig. 1.

Place the screen, thus formed, in front of a petroleum lamp and exclude the daylight from the side

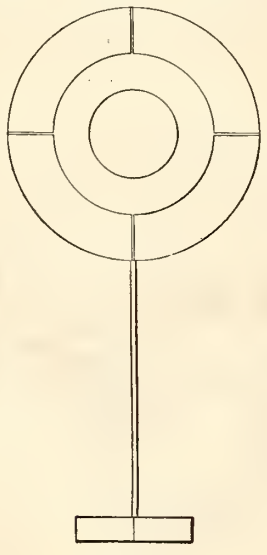


FIG. 1.

thus illuminated. The other side of the screen is illuminated by the light of the sky admitted through a distant window. The cardboard ring is thus illuminated on one side only by the lamp; on the other side, only by the daylight. The translucent paper transmits the lamplight to the side facing the window, while it transmits the daylight to the side facing the lamp. On the side of the screen facing the window the cardboard ring appears cyan blue, while on the side facing the lamp the ring appears orange yellow.

*Hues of the sides of the ring.*—An idea of the hues and intensities of these colors, which cause astonishment even in those who are experimenters in chromatics, will be given by the description of the following experiments.

By means of a Bunsen photometer disk I adjusted the distance of the lamp from the screen so that I obtained as nearly as I could judge equal illumination of the sides of the screen. I then found that the blue was matched in a rotator by a disk having a sector of 60 parts of the circumference of Prussian

FIG. 2.

blue, with a sector of 10 parts of emerald green and of one of the many colored disks given me by Professor O. N. Rood and was marked, "Blue between cyan blue and the ultramarine of the physicist, but nearer the latter. Near F and on its more refrangible side. Made with Prussian blue." The blue on this disk appeared as saturated in hue as could be made by the pigment.

The match of the color of the side of the ring facing the lamp, L, in Fig. 3, was obtained by placing a

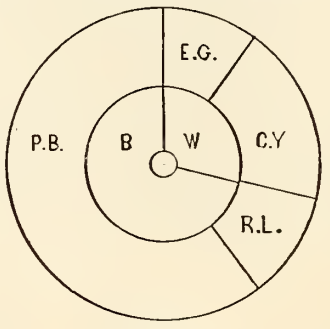



FIG. 3.

silvered mirror, M, so that the reflection of this side of the ring, S, was seen close to the rotator, R.

The color of the cardboard ring facing the lamp was matched by the rotation of a disk formed of 50 parts of chrome yellow, 30 parts of red lead (red orange) and 20 parts of white cardboard. Such appears to be the hue of the light of a petroleum flame when compared, in this manner, with the light of the sun.

The petroleum flame used in these experiments was that of a Belgian burner giving about 35 candles. The daylight was obtained from a window 85 cm. square; the lower half of which, when viewed from the screen, was occupied by the snow-clad surface of an opposite hill. The day was very clear, and the sky very slightly tinged with blue.

*The colors of the sides of the ring of the screen are complementary.*—I combined the Prussian blue, emerald green, chrome yellow and orange red on a disk on the rotator, and found that when the disk was formed of sectors having 60 parts of Prussian blue, 11 of emerald green, 19 of chrome yellow and 10 of red lead, I obtained a gray which was exactly matched by a central disk formed of 71 parts of dead ivory black and 29 of white cardboard. (See Fig. 2.) These measures gave the following equation:

$$\left\{\begin{matrix}60\text{ Prussian blue}\\11\text{ Emerald green}\end{matrix}\right\} + \left\{\begin{matrix}19\text{ Chrome yellow}\\10\text{ Red lead}\end{matrix}\right\} = \text{Gray}\left\{\begin{matrix}71\text{ Black}\\29\text{ White}\end{matrix}\right\}$$

It is rather difficult to get the exact match on the rotating disk of the hues on the front and back of the cardboard ring of the screen, on account of the illumination of these surfaces. The rotator must be placed nearer the window than the screen, so that it is well illuminated.

The equation shows that the cyan blue of 60 parts of Prussian blue + 11 of emerald green is complementary to an orange yellow of 19 of chrome yellow + 10 of red lead. The hue of this orange of the lamp

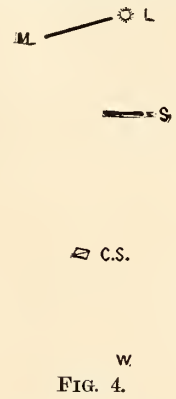



FIG. 4.

side of the ring, as given by the rotator, was 50 chrome yellow + 30 red lead + 20 white, which mixture is approximately in the proportion of 19 to 10. The correspondence of the two experiments is, I suppose, about as near as could be expected from the difficulty of matching the illuminated hues of the ring of the screen.

The small central disk on the rotator gave a gray of 71 parts of ivory black + 29 of white cardboard, which matched the gray given by 71 parts of cyan blue + 29 parts of orange. Calling the intensity of the orange 100, we have $100 \times 29 = 71\ I$, which gives for I (the intensity of the cyan blue) only 40·8 per cent. of that of the orange.

*The orange yellow of the side of the ring facing the lamp and of the side of the translucent paper facing the daylight is complementary to the cyan blue of the side of the ring facing the daylight and of the side of the translucent paper facing the lamp.*

In Fig. 4, L is the lamp; S, the screen, which in this experiment is deprived of the border of translucent paper; W, the window; M, a silvered mirror which reflects the back of the screen to the eye, which looks through an achromatized double refracting calc spar prism at CS, and sees two images of the side of the screen reflected from the mirror and two images of the side of the screen facing the window. By suitably inclining and rotating the calc spar prism these images may be brought into the positions shown in Fig. 5, in which A represents one of the images of

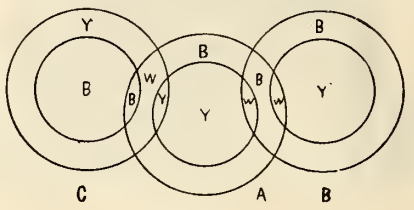



FIG. 5.

the side of the screen facing the window; B, the other image of the same; C is one of the images of the side of the screen facing the lamp and seen by reflection from the mirror.

The overlapping of these images, when the illumination is properly adjusted, gives the following results as shown by the letters in Fig. 5, where B stands for cyan blue, Y for orange yellow, and W for white. The translucent paper, Y, of B overlaps the ring of A and gives white, and the blue of the ring of B overlaps Y of the translucent paper of A and gives white. In the same manner the orange yellow of the cardboard ring of C overlaps the blue of the ring of A and gives white. Where the ring C overlaps the translucent paper of A there is a more intense orange, and when the blue of the translucent paper of C overlaps the blue of the ring of A we have a more intense blue. On bringing B of the translucent paper of C over Y of the translucent paper of A we have white.

*Experiments on the complementary colors of gratings.*—Out of thin cardboard, such as is used for thin visiting cards, I cut gratings with a dividing engine. (See Fig. 6.) The widths of the spaces cut out of

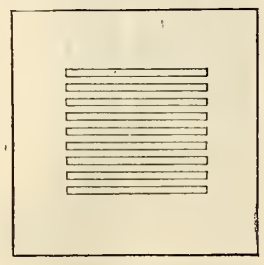


FIG. 6

these gratings exactly equaled the breadths of the cardboard left in the grating. Gratings were thus made having spaces of 1, 2, 3, 4 and 5 mm. The cardboard is rendered opaque by coating one side of it with ivory black in dilute shellac varnish. After it has dried the cardboard is well flattened before it is fastened to the surface of a piece of hardwood on the dividing engine. The cutting edge of the cutter for this work must have a very acute angle. I made one by grinding down a rod of Stubs' steel. Heating this to a dull cherry red and then forcing it into a large ball of beeswax gives the edge of the cutter the required temper, without the necessity of subsequently "letting it down." The blackened side of the gratings was covered with the "Alba tracing paper." The grating was mounted back of an opening in a black cardboard screen, so that only the white grating was exposed. Two other black screens, Wh and Y of Fig. 7, having openings of the same size as the grating and covered on the back

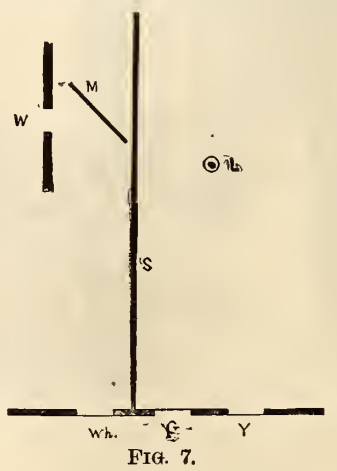



FIG. 7.

with the translucent paper, were placed on either side of the grating, G. In Fig. 7, L is the lamp. The window is on the other side of G. The screen, S, divides the apparatus so that the light of the window, W, reflected by the mirror, M, on to the screen,

* From the *American Journal of Science*, vol. xlvi., July, 1893.

† Trials with many kinds of paper showed that a white linen tracing paper was the best. It is not possible to describe this so that one may be sure of selecting a similar paper. It was obtained of Keuffel & Esser, Fulton Street, N. Y., and sold as "No. 202 Alba tracing paper."

Wh, cannot fall on G or on Y, which are only illuminated by the lamp, L.

The translucent paper of the grating, G, and of the screen, Y, appear orange yellow. The bands of white cardboard of the grating appear cyan blue. The translucent paper of the screen Wh is white.

Sit a little to one side of the grating so as not to intercept the light from the window, and look at the grating through the calc spar prism. Rotate it till the blue bands of the grating are superposed on the orange bands, when if the surface of the grating is equally spaced, the superposed surfaces appear white when compared with the white of the screen, Wh. Without the screen, Wh, the eye has no term of comparison and may take a yellowish white for white. The illumination of the screen, Wh, should be made equal that of the superposed images of the grating.

When this experiment is carefully made, with the proper illumination, the effect is suprising when, in favorable conditions, on rotating the prism you see the grating actually obliterated with no bands visible, but only a uniform white surface. The grating with spaces of 3 mm. gave the best results.

In experiments with the screen, Fig. 1, formed of the cardboard ring and the translucent disk, it is easy, by altering the relative intensities of the daylight and lamplight and by changing the distance of the lamp from the screen, to produce great changes in the saturation of the contrast colors. Indeed I have sometimes thus obtained, toward nightfall, a cyan blue so saturated in hue that little or no white was required in the disk of the rotator to match the color on the ring. In the same manner similar changes in color have been observed in the hue of the ring illuminated by the lamp.

On illuminating one side of the screen by daylight and the other by the white light of a Welsbach incandescent lamp, and then placing colored glasses or films of colored gelatine between the screen and the Welsbach lamp, effects of contrast are obtained which are so readily imagined by the physicist as to require no description; but they are worth viewing.

*Increase of the purity and luminosity of the contrast colors by a rotating screen.*—Make a disk of white cardboard of 27 cm. diameter, with eight sectors cut out of it, and cover it with translucent paper, so that the paper extends beyond the disk and makes a border 3 cm. wide. A circle of 8 cm. in diameter is left in the center of the disk and a ring of 1½ cm. on its border. This disk is shown in Fig. 8, but with only six sectors.

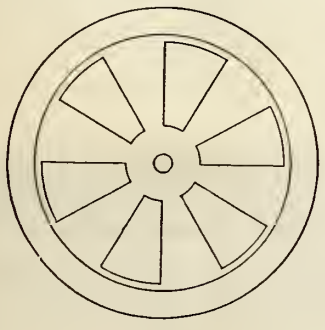


FIG. 8.

It should have eight. It is placed between the lamp and the window, and rotated with a velocity of one revolution in about 1¼ seconds, while it is viewed on the side facing the window. The blue sectors thus take successively the places just before occupied by the sectors of orange yellow, and the effect is to heighten the contrast color in such a remarkable manner that the blue sectors by their more intense color appear separated from the rim and central circle and appear in a plane farther from the eye than the plane of the center and rim. On the side of the disk illuminated by the lamp the same effects are produced, only they appear more marked. A change will also be observed in the hue of the advancing and following edges of the sectors, on both sides of the disk; the advancing edges appearing more saturated in hue than the following edges.

*A mode of observation by which contrast colors are intensified.*—Simultaneous contrast colors are generally viewed by placing gray or tinted surfaces on colored grounds, or by the juxtaposition of colored surfaces. The effects thus produced are of such constant occurrence in the paintings of artists, and in colored fabrics, that their study is of great interest. The contrast colors thus produced have generally been studied by simply placing on a colored ground smaller gray or tinted surfaces and observing these with the unaided eye. This method has been improved by H. Meyer,* who viewed the gray on the colored ground when both were covered with white transparent paper.

The mode of observation I have devised for the study of contrast colors is as follows. A glass tube of 2·7 cm. in interior diameter and 10 cm. long is coated on the outside with black Japan varnish, so as to have reflection only from the interior surface of the tube. A ring of 3 cm. diameter with a central opening of 2 cm. is cut out of gray paper. The gray of this ring was matched on the rotator by a disk having 57 parts of ivory black and 43 parts of white Bristol board. This ring, placed on a surface of emerald green, appears of a rose color. If at the distance of distinct vision we look at the ring through the tube, we shall see the ring by direct vision inclosing a circle of green and surrounded by a ring of emerald green, and this inclosed by a rose-colored ring, produced by reflection of the gray ring from the interior of the tube, and surrounding this ring is another of emerald green, as shown in Fig. 9; in which R and R are the red rings and G, G, and G the circle and the two rings of emerald green.

The hue of the rose-colored rings as seen through the tube is much more intense than the hue of the ring viewed on the emerald ground with the unassisted eye. Experiments made with the aid of an achromatized calc spar prism, and by matching on a rotating disk the colors of the gray ring on an emerald green ground, showed that the intensity of the contrast color, as seen with the reflecting tube, is nearly double what it is when viewed by the eye alone. The color of the ring when viewed by the unassisted eye was matched on the rotator by a disk having 30 parts of Chinese vermilion + 7 of "Hoffman's violet R R R" + 34 parts of ivory black + 29 of white Bristol board. As seen through the reflecting tube, the match appeared to be given by 57 of Chinese vermilion + 15 of "Hoffman's violet R R R" + 28 of white Bristol board.

Another tube 4·5 cm. in diameter and 18 cm. long gave excellent results, with two reflected rings, and on nearer vision, with four reflected rings. A tube, suitable for these experiments, is selected by closing one of

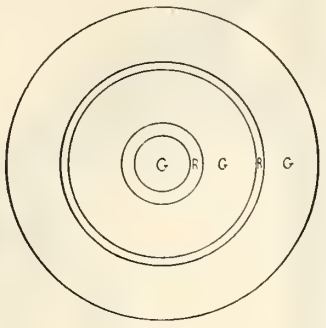



FIG. 9.

its ends by a disk of cardboard having a pin hole at its center. When the end with the pin hole faces the sky and we look through the other end, we see bright rings caused by the reflection of the light of the pin hole from the surface of the tube. If these rings are circular and concentric, the tube is of a circular section and its axis is a right line.

The value of this mode of observation is shown by the following experiments. Place the ring of gray paper, or a circle of gray paper, about 1½ cm. in diameter, on a surface painted with cobalt blue, not too saturated. The gray ring, or circle, appears of an orange tint. Place a similar gray ring, or circle, on a surface lightly washed with emerald green. It appears pinkish. The difference between the hues of the ring when viewed on the cobalt blue and on the emerald green, though decided, is not strongly marked; but if viewed through the reflecting tube, the ring on the cobalt blue appears of a rather intense orange and the ring on the emerald green appears of a rose color. When so viewed the difference in these hues is strongly marked.

Pieces of cardboard, painted with the following colors, were arranged in pairs. Orange yellow on the less refrangible side of D and orange yellow on the more refrangible side of D. Greenish yellow and yellowish green, both made with gamboge and Prussian blue. Purple of violet end of spectrum with added red, made with Hoffman's violet R R R, and violet between G and H, Young and Muller's fundamental color. Place a pair of the colors, as given above, side by side and on each put a gray ring, with a reflecting tube over each ring. When viewed by the unassisted eye the differences in hue are slight and difficult to define; but when viewed in rapid succession through the adjoining tubes the differences in hue are decided and may be readily matched in color with disks on the rotator.

(*To be continued.*)

## LAUSSEDAT'S HEMIPERISCOPIC CAMERA LUCIDA.

THE application of Wollaston's camera lucida to the drawing of perspectives designed for figured plans is due to Captain Laussedat. We shall describe neither the classical apparatus nor its modifications, which are to be found in all treatises on physics. We shall merely say that the double reflection prism that forms the essential element of it has, for upright section, a quadrilateral, two sides of which make an angle of 90°, while the other sides make an angle with each other of 135° and with the two first sides angles of 67·5°. The edges of the prism being arranged horizontally, a luminous ray comprised in a plane at right angles with the edges, after entering through one of the rectangular faces, undergoes two total reflections upon the two 135° faces and makes its exit through the other rectangular face in taking a direction at right angles with that of the incident ray. The eye situated above the sharp angle of the face of exit then perceives a virtual image

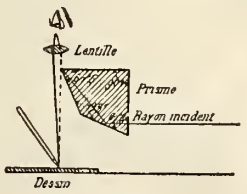



FIG. 1.

upon the plane of the drawing. But precisely because such image is virtual, its displacements at every instant accompany those of the eye, which, having no datum point, cannot remain fixed. There necessarily result grave errors.

Captain Laussedat has rendered the use of the camera lucida very practical by a few very happy modifications. He has, so to speak, fixed the position of the eye by shaping the upper horizontal face of the prism in the form of a spherical half cap whose center is upon the perpendicular to the horizontal face of the ptism, passing through a point of its edge. The optical center and the point of view of the perspective are then fixed, and the drawing becomes very easy. The determination of the constants of the apparatus is equally so. The board and the edges of the prism having been arranged horizontally through the aid of a small spirit level, the point of view is projected upon the board with a plumb line, and we have the principal point. The horizon line passes through this point and is obtained by measuring a perpendicular to the image of any vertical whatever. The distance from the point of view to the drawing board is measured directly with a divided rule. We have thus upon the plane of the drawing all the elements capable of serving for the construction of the angles of the visual rays reduced to the horizon and of figured projections of the various points (Fig. 2).

When the objects are very distant, the images obtained upon the plane of the drawing by means of the camera lucida are too small, and, in order to enlarge them, Captain Laussedat in 1854 conceived the idea of adapting the camera lucida above described to the

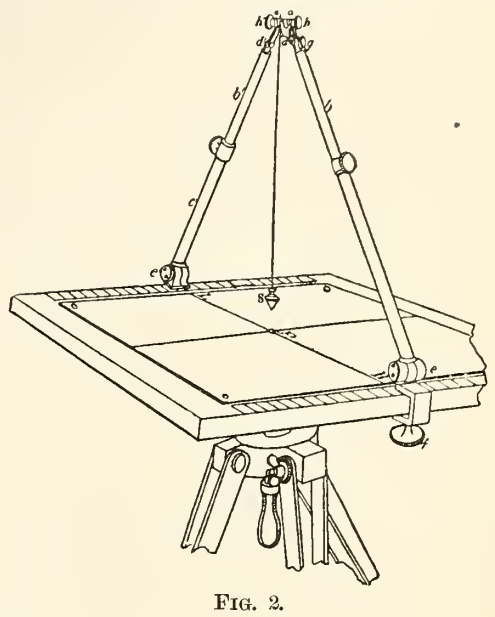


FIG. 2.

ocular of a magnifying telescope. This process was used during the war of 1870 for studying the approaches of the Germans at the siege of Paris. Captain Laussedat styled his apparatus a telemetrograph.—*Le Genie Civil.*

## A PHOTO-TELEGRAPH.

By H. C. JOHNSON.

I HAVE taken considerable interest in the subject of the transmission of pictures or images by electricity, and in view of the article on this subject which appeared in your issue of Oct. 21, though not claiming to be an electrician, I have concluded to present the results of my own observations. It does not seem improbable that we shall some day be able to produce a device by means of which this much sought for result may be attained. Some one has stated, in substance, that the general principles involved will be the conversion of the picture to be transmitted into a series of electrical pulsations, and afterward causing these pulsations to act upon a receiver at the distant end of the line in such a manner as to reproduce the picture. It seems to me that the next point to be considered is whether it will be possible to transmit each illuminated point in the picture at (practically) the same instant over a single wire, or whether these points are to be transmitted successively, but with such great rapidity that the picture will appear to his eye as complete. I say this is the next point to be considered, for I have given considerable thought to the matter of transmitting each point independently, as, for instance, by separate wires, and while it may be possible even now to devise a construction by means of which the desired result could, theoretically, be realized, it is doubtful if a practical device will ever be made on this principle. The construction described in the article above referred to is based on this idea. Using the words of that writer, "the two instruments would, therefore, be connected by a large cable made up of many thousands of small insulated wires." Imagine, if you can, two telephone instruments connected by one thousand wires, even though they were formed into a cable. The transmission over a single wire of each point in the picture at the same instant would, undoubtedly, be the ideal method, but with our present knowledge it seems, perhaps, somewhat more visionary than the

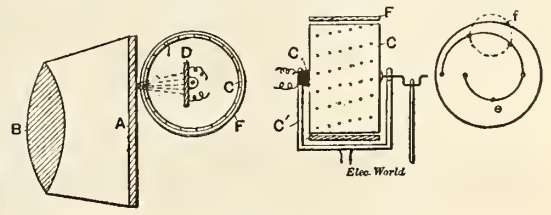



PHOTO-TELEGRAPH.

successive transmission of these points with such speed that the picture will appear as a complete thing. When the laws of physics in certain directions are better understood, however, the first method may not prove to be an impossibility. Some little time ago I worked out a device embodying the second method spoken of. While I fully recognize that there are many obstacles which it is difficult to overcome, and it is not claimed for a moment that the present construction does overcome any large proportion of these, yet the instrument has some features which may be of interest.

In the sketches A represents a plate of ground glass on which the picture to be transmitted is first received; in front of this plate is located a lens, B. The hollow, perforated cylinder, C, adapted to be revolved by any suitable means, is mounted in a vertically reciprocating frame, C', and incloses a selenium cell, D, which is secured to the frame, C', at C. The casing, F, which encircles the perforated cylinder, is provided at that portion nearest the plate, A, with a narrow horizontal slab, while the perforations or apertures are arranged

* Pogg. Ann., xcv., 170,

in oblique lines. As a result, only one perforation at a time can register with the slab in the casing, the object being to allow the rays of light from only one point on the plate, A, to reach the cell, D, at any particular instant. It will be seen that the revolution of the cylinder alone will provide for transmitting only one horizontal colored line in the picture, but as the frame carrying the cylinder is simultaneously reciprocated all of the points in the picture will, within a very short space of time, make their individual variation in the resistance of the selenium cell. I regard as especially important the construction whereby each illuminated point is allowed to throw its rays on the selenium cell for only an instant, the light being then entirely cut off until the next perforation registers with the slab. By this means I overcome what seems to be a grave difficulty in certain instruments in which the transmission of points is sought to be accomplished by means of a revolving disk having a series of apertures, *e*, arranged spirally near its edge (see Fig. 3), the disk being so located, say at the end of a tube, *f*, through which the rays from the picture pass, that light may reach the selenium cell through only one aperture at a time. The receiver has a similar disk, and both are revolved synchronously. It will be noted that the operation would be what might be termed a "transmission of lines," that is to say, there would be transmitted through each perforation a curved line of the picture, instead of only a point in a line. If the varying shades of an entire line were presented to the selenium cell without intermediate relief by total darkness, the cell would be less efficient, if not utterly useless for the purpose intended. The receiver of the present device consists of a plate similar to A, on which the picture is to be reproduced, and a perforated cylinder mounted and revolving in a reciprocating frame. Instead of the selenium cell, however, there is located within the cylinder a source of light and suitable means for varying the intensity of its rays to correspond with the varying strength of the electric current, which in turn depends upon the resistance of the selenium cell, and this resistance varies in proportion to the brightness of the point in the picture which may be influencing the cell at any particular moment. It will be understood that the cylinders must be operated synchronously and with sufficient rapidity to cause it to appear to the eye that all these rays of light of different degrees of intensity are thrown upon the plate at the same instant. It is probable that experiment alone would fully demonstrate how frequently it would be necessary to reproduce each particular point in the picture in order to accomplish this result. Should it be found that the resistance of the selenium cell could not be varied with sufficient rapidity, or that that portion of the receiver designed to throw rays of light of different colors or degrees of brilliancy could not be made to operate properly, the same principle could be extended almost indefinitely by the use of a number of cylinders, with their attachments, each transmitting only a small portion of the picture, although this would, of course, involve a few more connecting wires.—*Electrical World.*

## MEGATHERIUM CUVIERI.

THE fossil shown in our engraving, which is from *La Ilustracion Española*, represents the gigantic fossil in the Museum of Natural Sciences at Madrid, and pertains to the Megatherium Cuvieri, which was found in

THE MEGATHERIUM CUVIERI.

quaternary ground on the banks of the river Luxan, about ninety miles from the capital of the Argentine Republic.

It was sent to the Museum in 1780 by the Viceroy, the Marquis of Loreto. This mammal, whose stature approaches that of the elephant, possesses some of the natural characteristics of the sloth, forming, in conjunction with other species of fossils, the family of the Megatheridos. From the form of its teeth it is observed that it lived upon vegetable food, and an examination of its skeleton shows that its normal position is not that of a quadruped, although its skeleton is so arranged in the Museum; but it is a biped, as the animal carries itself upon its hind legs and supports itself upon its tail, which is large and strong, much in the same manner as the kangaroo.

This more natural position of the animal is shown in our smaller engraving, which was taken from the gigantic skeleton cast of the Megatherium Cuvieri exhibited at the Philadelphia Exposition in 1876, by Professor Ward, of Rochester, N. Y. Concerning this creature, Professor Ward says: The first fossil remains of this animal were discovered in 1789, near Buenos Ayres, and were first transmitted to Madrid in Spain. The original bones, of which this specimen is a copy, were found in the same pampean deposit between the years 1831 and 1838, and belong partly to the Hunterian Museum and partly to the British Museum. To give to this singular quadruped its proper position in the animal kingdom was, for many years, a problem in comparative anatomy which the savans of Europe could not solve. Led astray by the huge carapace of the glyptodon found near it, the majority called it a mammoth armadillo. Cuvier, who gave it its generic title, thought that it combined the characters of the sloth, ant-eater, and armadillo. The merit of throwing a flood of light on the structure and nature of this the most remarkable of all fossil animals was reserved for the celebrated English geologist, Professor Owen, who conclusively proves that the megatherium was a ground sloth, feeding on the foliage of trees which it uprooted by its great strength.

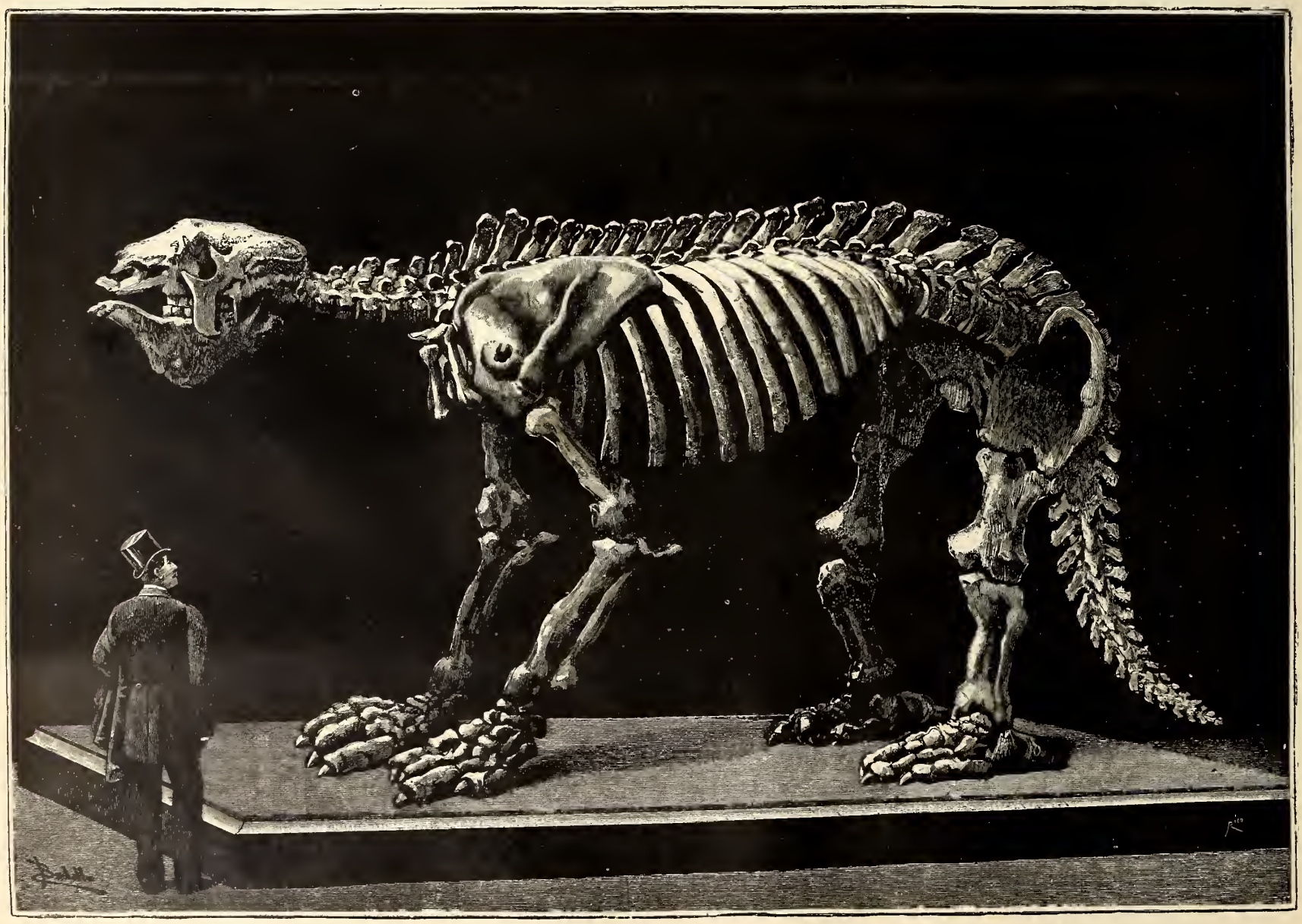
The extreme length of the mounted skeleton is seventeen feet and nine inches; its height from the pedestal to the top of the spinous process of the first dorsal vertebra is seventeen feet. No other fossil so exceeds its modern representative as the lordly megatherium surpasses the pygmy remnant of the tardigrade race. One is tempted to join the Spanish naturalist who objected to the place assigned to the megatherium because "all the other edentates could dance in his carcass." But that there is the closest affinity between it and the diminutive arboreal sloth is now undeniable. The number of teeth, their deep insertion, equable breadth and thickness, deeply excavated base, inner structure and unlimited growth, and the absence of canines, are characters common to both. The part in which the megatherium least resembles the sloth is the tail; and, as a general rule, in those modifications of structure in which it differs from its living analogue it approximates to the ant-eater.

The head of the megatherium is remarkable for its relatively small size, for the extraordinary depth of the lower jaw, and for the great size of zygomatic process. The length of the skull is thirty inches—three inches less than the Asiatic elephant. The formation of the muzzle indicates the possession of a short proboscis.

The spinal column consists of seven cervical, sixteen dorsal, three lumbar, five sacral, and eighteen caudal vertebræ, and measures fifteen feet in length, or three feet more than the elephant's. The circumference of the skeleton at the eighth rib is eleven feet.

The megatherium differs strikingly from existing quadrupeds of corresponding bulk in the vast proportions of its anterior extremities. Its clavicle, fifteen inches long, is the longest known. The foreleg bespeaks enormous strength; with the foot it is seven feet four inches in length.

The hind legs appear more like columns for support than organs for locomotion, and, with the hind feet, are models of massive organic masonry. The heel bone alone has the extraordinary length of seventeen inches



THE MEGATHERIUM CUVIERI—FOSSIL IN THE MUSEUM OF NATURAL SCIENCES, MADRID.

and a circumference of twenty-eight inches. The monster walked like the ant eater, on the outside edge of its foot, on a marginal hoof-like callosity. The middle toe of the hind foot and fourth digit of the fore foot were armed with powerful claws. The magnitude of the tail fills the observer with wonder. When clothed with flesh it must have been more than six feet around at the greater end. With the hind legs it formed a tripod, upon which the animal rested when obtaining its food. It would be interesting to know something of the daily life of the animal whose colossal size was united to such strange anatomy. As the brain of the megatherium was less by nearly one-half than that of the elephant, we infer that he was a creature of fewer instincts. Nevertheless his contemporary quadrupeds must have acknowledged him as the head of the animal kingdom. To the tongue of a giraffe and the proboscis of a tapir there was added the power of rotating the bones of the forearm. These prehensile organs were suited to a leaf-feeder. That the animal was not carnivorous is settled by the structure of its molar teeth; it lacks incisors, therefore it was not a ruminant. But if the great animal fed on foliage, how did it obtain it? The elephant gathers its food with a long proboscis. The giraffe, standing on stilt-like forelegs and reaching out its attenuated neck, plucks the high branches with long flexible lips and muscular tongue. The megatherium could imitate neither. The forearms were plainly formed for grasping, and not climbing or digging; they were instruments of tremendous strength, evidence of which is furnished by the deep grooves and sharp ridges on the radius and ulna, the starting points of stout tendons and muscles. The moment we estimate this force, the colossal proportions of the hind extremities lose their anomaly, and harmonize with the front. The application of the forearms to the work of tearing down a tree would demand a corresponding fulcrum such as we find in the heavy pelvis, the ponderous tail, and the massive hind legs.

When stripping the trees it had prostrated, its position was probably a reclining one; and Prof. Agassiz ventured the opinion that this crouching attitude was constant to the animal, and that it crept along with the full length of the forearm resting upon the ground.

The pampas, where the remains of the great fossils have been chiefly found, are vast plains stretching from the mountains of Brazil to Terra del Fuego. Palms grow at one end, while snow covers the other almost the entire year. The soil is chiefly a dull, reddish, slightly indurated argillaceous earth, with here and there calcareous concretions; underneath are beds of stratified gravel and conglomerate. These deposits constitute the pampean formation, which varies in depth from twenty to one hundred feet. They were slowly formed at a time when the Atlantic reached far westward to the foot of the central mountain chain, down whose banks the rivers brought the detritus, and spread it beneath the waters in level layers at some distance from the shore. Carcasses of animals floated down upon the same streams, and, reaching the quiet waters, sank down in their muddy bed. The whole area has since been elevated, the estuary mud has been converted into wide and level plains, and the shores and submarine banks of a former sea now form low headlands along the present coast. It was in this recent formation—referable to the Pleistocene period, because most of its shells are still living in the ocean—that the megatherium was entombed. Its bones are almost exclusively found in the cliffs and steep banks of rivers—thus far, the rivers Salado and Luxan. The race was not exterminated by some great cataclysm, for the small bones, like the knee-cap of a contemporary mammal, were discovered by Darwin in the same deposit, all lying in their proper relative position. Like the aborigines of our own continent, like the dodo of Mauritius, the edentate giants perished one after another, in the lapse of infinite ages, by those changes of circumstances in the organic and inorganic world which are always in progress.

## EARTHQUAKE AT KUSHAN, IN PERSIA.

A TELEGRAM from Teheran, the capital of Persia, gives further details of the recent disastrous earthquake in Kushan and the surrounding district. The first shock was felt on November 17, at half-past seven in the evening. It completely destroyed the town of Kushan and all the villages within a distance of seven miles, many of the inhabitants being buried beneath the ruins. The shocks continued until November 24. Up to that date, about a hundred and sixty distinct shocks were counted. On November 23 a great storm occurred. Heavy rains fell during the day and snow during the night, greatly increasing the sufferings of the inhabitants, who were camping out in tents. Supplies of food were being sent from the surrounding district and from Meshed, where slight shocks of earthquake have also been felt. According to the official reports the total population was 20,000, and of this number three-fifths were killed, while 50,000 animals perished.

The town of Kushan, in Khorassan, the northeastern territory of the Persian empire, is situated not very far south of the Russian Transcaspian frontier, being seventy-six miles south of Askabad, and nearly a hundred to the northwest of Meshed, visited by our special artist, Mr. William Simpson, on his journey to accompany the Afghan Boundary Commission. It is several hundred miles beyond the capital of Persia. The province of Kushan, a broad fertile valley, watered by the Atrek River, extending sixty miles below the Shah Jehan range of mountains, was an old Kurdish principality, and its governor is styled the Ilkhani. In the Hon. G. N. Curzon's excellent book of travel and statistical study we find some account of the town, which contained 12,000 people. The curious earthen mounds with doors, in the foreground of our view, are brick kilns.

The latest telegram, dated from Teheran, December 1, says: "Kushan is a heap of ruins; not a house remains standing. It is estimated that the loss of life has been two deaths to every house. There is some talk of building a new town to the eastward."—*The Illustrated London News.*

THE CITY OF KUSHAN, IN PERSIA, RECENTLY DESTROYED BY AN EARTHQUAKE.

## THE JAPANESE EARTHQUAKE OF 1891.

By RALPH S. TARR.

THE Japanese are not unaccustomed to the quaking of the earth, but shocks as disastrous as that of October 28, 1891, are rather rare even in Japan. The last earthquake of marked violence, in any way comparable with this one, occurred in 1854, and since 1633 there have been but twelve severe shocks which may be ranked with that of last year. Scarcely a day, however, passes without some jarring of the earth which is appreciable to the senses, and those of us who live in a region comparatively free from earthquake shocks, such as the eastern United States, would be very much alarmed at shocks which are passed over with very little notice in Japan, and would have our confidence in the stability of nature very much disturbed. Centuries of experience have taught the Japanese that the earth is far from being the *terra firma* which we are accustomed to consider it.

Japan is doubly unfortunate in being the seat of the two main causes of earthquakes. It is, in the first place, a volcanic center, which always carries with it as a necessary adjunct recurrent jarrings of the earth, for each time the pent-up lava, struggling to reach the surface, overcomes some obstacle and rends asunder the deep-lying rocks, an earth jar is started which reaches the surface as an earthquake shock. Moreover, the rocks are still in a state of strain, for the country is geologically young and perhaps still growing, and this always means accompanying earthquakes, for when rocks are bent and folded or differentially elevated there comes now and then a time when the strain is relieved by a break or a slip in the rocks, and this sends a jar through the earth. New Zealand, Chile, Peru, and many other parts of the earth are in this state, and here earthquake shocks are liable to be both numerous and violent. These two theories do not exhaust the possible causes of earthquakes, but from them the great majority of such shocks result, and while we cannot exclude the other causes from Japan, we certainly can say with safety that nearly all are caused by the one or the other of these accidents.

So liable are the Japanese to be rudely shaken that the investigation of earthquakes has in that country become one of the most earnestly studied sciences, and the Seismological Society of Japan has become famous the world over. There is no part of the earth where every form of earthquake is as carefully studied as there, for it is the hope of the nation that as a result of this study it may be found possible, in a measure at least, to predict the approach of severe shocks. The chief damage to life in an earthquake comes from the falling of houses, and if the people can be warned in time to seek safety without, it will be a great boon to the nation. Probably in no civilized country in the world is the danger from falling timbers reduced so nearly to a minimum as in Japan, for the centuries of disastrous experience with earthquakes have taught these people to construct their dwellings with special reference to the possibility of destruction by this means. A shock which in Japan kills ten thousand people would in our own country, if in an equally populous region, destroy fully ten times that number.

The disaster of 1891 has been recently reported upon by the scientific societies, but before this we knew from the native newspaper reports enough about the shock to state the facts of general interest. It is a curious fact that the Japanese expected some such calamity to befall the country on or about His Majesty the Emperor's birthday, which occurred only seven days after the shock. There is no obvious reason for this superstition, since violent earthquakes in Japan do not recur at regular intervals; but the coincidence will go far toward fixing superstition in the minds of the common people, who are already inclined toward it.

The region visited by this earthquake is a well settled one, and one into which modern improvements had been quite extensively introduced. Mino Province, about two hundred and twenty-five miles from the capital, was chiefly affected; but the shock was felt in Yokohama and Tokyo, there being in the latter city some nineteen shocks in all, each sufficiently sharp to cause alarm, but none having force enough to do any particular damage. About four thousand square miles were visited with almost instant devastation, eight thousand people were killed by the falling of buildings or by the fire which followed, ten thousand were wounded more or less severely, and ninety thousand houses were destroyed. On the first day there were seven hundred minor shocks, and in a month seventeen hundred were recorded.

The population of Aichi and Gifu-kens was about two million four hundred thousand, and of these seven thousand five hundred were killed and nine thousand four hundred and fifty wounded. That is to say,

about three in every thousand were killed and four wounded. The death rate was thus not very great, though the aggregate was large; but this small death rate was the result chiefly of the character of the dwellings, and had they been made of brick of several stories, instead of one story wooden dwellings, the destruction would have been much greater. As it was, full half a million people were rendered homeless.

Gifu and Aichi, where the chief damage was done, were the centers of an important porcelain industry, and were reached by railroads and roads which crossed the streams by substantial bridges. We have, therefore, an opportunity to observe the effects of a severe earthquake shock in a region having many of the improvements of modern civilization, and some of the effects are most marked and peculiar. The foreign made buildings, with their tall chimneys, were in many places completely wrecked; but, fortunately, the shock occurred at a time when they were not occupied, and the destruction of life was less marked than it might have been later in the day.

At about half-past six in the morning of the 28th of October a rumbling noise was heard, followed almost immediately by a violent shock. The first shock, which caused the fields to rise and fall like waves and gave to almost every one a sensation resembling seasickness, brought nearly half the houses in Gifu to the ground, and many of those which still stood yielded at the second or third shock. At eight o'clock a fire broke out in four places simultaneously, and before it was subdued, the next day at noon, nearly seventy per cent. of the town was in ruins. The people were with difficulty enlisted in the fight against the flames, for more than half of them were broken-hearted over the loss of their home or were engaged in the sorrowful task of searching for lost loved ones or in assisting the wounded. People without home or shelter were forced to live in the open air, and the whole town was a camp and a hospital combined. Many who escaped unharmed were made ill from exposure, and in this indirect way died from the effect of the earthquake.

There are many interesting and pathetic stories told of the effects of and phenomena attending this shock. At Nagaya about forty Christians were assembled at an early prayer meeting in the large foreign building of the Methodist Protestant school. In the midst of the meeting there suddenly came the sound of distant rumbling, and almost immediately a decided quaking began. For an instant no one moved, expecting it to be over soon, but the rumbling increased to an awful roar and the building began to creak and rock, and as the terrified crowd was half out a flying mass of brick and tiles came tumbling down on them. The writer of the account from which the above was taken was one of the party, and he says: "The scene was truly awful to any one not accustomed to a field of battle, to see all those dead and wounded lying motionless or gurgling bloody fountains from every aperture. We were busy enough with this scene, but the whole city was in an uproar. Wild shrieks, shouts, and innumerable noises filled the air, while every few moments came the terrible thunder from the angry earth. Running through the city to call doctors, I found that none could be obtained for any price; but many streets blocked with fallen houses, and others choked with people rushing to and fro or standing dazed and gazing at the ruins."

There are many accounts like this, and every traveler through the region and every correspondent had some tale of disaster, some heartrending story to relate. There were children who had lost their parents and knew of no living relatives, mothers who had lost their children, and husbands whose wives lay beneath the trembling ruins, all rushing about in indescribable anguish or sitting about stunned and stupefied by the terrible calamity which they had not yet fully realized. The scene must have been an awful one!

Not only were houses thrown down, but much damage was done to the earth itself. The region most severely visited was, as is often the case in an earthquake shock, the alluvial lands. The rice fields were tossed up and down and rent asunder, and all the roads in the most rudely shaken sections were rendered impassable except to pedestrians, by the crevices which crossed them. This cracking open of the earth is a common accompaniment of severe earthquakes, and in this shock cracks were found having a depth of fifteen to twenty feet and a width at the top often fully as great. In the great Calabrian earthquake, as well as in others, these cracks opened and closed, engulfing and entombing people; but in the Japanese shock no cases of this sort were reported.

As in all earthquake shocks, there were some peculiarities in the distribution of violence. In some cases parts of one village were destroyed, while other parts were only slightly damaged, and in neighboring villages the effects of the shocks were often widely different. No cause can now be assigned to this; but undoubtedly when the official report is made it will be found that these variations resulted from some peculiarity of the underlying rocks or soil. In some instances, however, these apparent differences in distribution of violence were due to the character of the dwellings. This was noticeably the case in a little hamlet of some twelve or fourteen houses on the bank of the Nagaragama. Only one of these houses had fallen, although from other evidences it seemed certain that the shock had been as severe here as elsewhere. The reason for this immunity seems to have been that the houses had slate roofs with eaves only slightly projecting instead of the usual tile or thatch roofs with projecting eaves. The houses were thus light and compact and could oscillate to a third of a right angle before falling over.

So violent was the earthquake that it is stated that in one place a grove of trees was bodily thrown to one side and remained permanently in their new position. As the earth opened water spouted out; the water in the wells became turbid and remained unfit to drink for several days, and the river Kiso changed its course, some parts becoming shallow or dry, and parts of the bank becoming converted into river channels. Much damage was done to the railroads and the telegraph service, the poles being thrown down and the wires broken. In one place the railroad track was thrown into a series of serpentine waves, as shown in one of the photographs. Especially were the railroad bridges damaged. Massive piers of masonry were cracked and destroyed, iron piers were overthrown or caused to sink into the river, allowing the bridge to settle in the middle, and upon the banks the earth was very commonly depressed beneath the track, leaving it suspended in mid-air.

A correspondent of the Hiogo *News* writes: "Passing clear of the bridge, an unprecedented view met our gaze. We could see as far as the Nagarawa. It was like a tobogganing road, with its devious undulations, twisted far, far out of the original direction of the line. Between these two bridges the earth subsided more than we had yet witnessed. Outside the bridge, the sleepers and rails were suspended in mid-air about eighteen or twenty feet, and the vibration, as we picked our way over them, was rendered the more unpleasant by a distinct shock of earthquake, whose approach was heralded by the low booming sound, as of distant thunder. Passing on, we crossed a small run spanned by a three-arched iron bridge. It had staggered at the impetus of the shock, the massive stonework pillars had fallen back and split, and it lay resting on the outer edge of the support almost turned completely over, only the rails preventing its being precipitated into the quivering river bed."

Within a very short time a scientific account of this earthquake has been published and its cause satisfactorily explained. It has been found, upon a study of the region visited by the disaster, that an actual break in the strata occurred, and that they slipped past one another or were faulted. This fault appeared at the surface in the form of a crack, on one side of which the ground was elevated several feet for a distance of many miles. The severe shock occurred at the time when the strata broke asunder; and the many minor jars which followed were caused by the slight slippings along the line of faulting.

It is very rare that the cause of an earthquake appears at the surface; but geologists who have studied mountain regions are familiar with the fact that in past geological times immense faults have been formed, sometimes with a throw of hundreds and even thousands of feet. In the case of an uplift of a few, perhaps a score of feet, a disastrous earthquake was caused. What, then, happened during the formation of so great a fault as some of those just mentioned? Perhaps much more violent earthquakes, but more probably many shocks. It does not seem probable that these faults were suddenly formed; but they were the result of successive movements. As the earth contracts, the strain becomes too great and the rocks break. They then rest for awhile, and again move along the same line, until ultimately they have moved hundreds of feet. This Japanese fault line will probably furnish a slipping plane again, and perhaps it has already done so in the past, for in a few scores of years all signs of the fault at the surface will be erased.

Many details might be added, but it seems hardly desirable to attempt any more than this general statement. The shock is but one of many which Japan has experienced, and was not as destructive as some that have occurred in other parts of the world, or even in Japan itself. It is, however, the only really violent shock which has occurred in a civilized country into which modern improvements have been partially introduced; and, although these improvements have by no means rendered the country under consideration in all respects comparable with our own, it still furnishes us with a basis for an estimate of the effect which such a shock would produce in our own country.

All European or American structures in the region visited by the calamity were badly damaged or completely ruined. While many of the native houses and castles stood through the successive shocks, the pottery and tile works, the high chimneys, the cotton mills, and other structures not Japanese in style were thrown down. What, then, would be the effect in New York City, or Boston, or Chicago if a shock even half as violent as this one should visit one of these cities? The heavy, projecting roofs, the tremendously high blocks and towers, and the poorly constructed houses would all fall with terrible destruction of life. This may never come to pass; but already in her short history this country has been visited by three distinctive earthquakes, one near Boston, one in the Mississippi valley, and one at Charleston, South Carolina, the last being, perhaps, the least violent of the three. It is probable that neither of these, unless the second be excepted, was as violent as that of Japan in 1891; but each shock was sufficiently severe to do much damage to-day in any of our large cities. Fortunately we do not dwell in a region where it can be said that such a calamity *will* befall us; but, unfortunately, we must confess that it *may* come.

[From the Gardeners' Magazine.]

## SINGLE CHRYSANTHEMUMS.

Improved systems of cultivation, coupled with the labors of enthusiastic raisers of new varieties, have for years past been steadily raising the standard of size in the Japanese chrysanthemum, until we have now flowers so magnificent as to compel a tribute of admiration even from the most ignorant observer. This has, however, proved a loss in one way, as these grand blooms are not by any means the most suitable for general floral decoration, and I heard a gentle complaint from a lady a few weeks ago, that she had nothing to cut from, though her gardener's display of chrysanthemums had been the admiration of the countryside. The illustration of single chrysanthemums and my remarks thereon will perform a genuine public service if they attract attention to this charming section, and especially to its suitability for cutting purposes. The flowers are not only beautiful individually, but form the most delightful and artistic arrangements in almost any way in which cut flowers can be used, and the blooms are so graceful in themselves that it is almost impossible to arrange them so that they do not produce a good effect. We have also an ample range of color, embracing all the principal shades, so that there is no lack in this respect. Another point of great importance to amateurs and people of small means is that the system of culture is of the simplest, neither requiring deep study to acquire nor large expense to put into practice. All that is necessary is to make neat bushy plants by pinching two or three times in the earlier stages, with ordinary care in watering, etc. In conclusion, I would strongly advise every lover of flowers to grow a few of these charming plants, and would also remark to the gardener who is already a chrysanthemum enthusiast that a few good bushes of the single varieties will provide a profusion of cut flowers through the season, and perhaps save him the annoyance of sacrificing show blooms to a purpose for which they are scarcely suitable.

Chas. E. Pearson,
Chilwell Nurseries, Notts.

VASE OF SINGLE CHRYSANTHEMUMS.

## THE HISTORY OF FOOTGEAR.

THE history of footgear dates back almost as far as that of human civilization. It is true that we find that, in ancient Egypt, the laborer, the soldier, and the man of the people went barefooted, but sandals formed part of the costume of the man of rank. They could not be worn, however, in the house of the king or in his presence. The Egyptian sandal was held in place by means of a strap that passed over the instep and was attached to another strap that likewise passed over the instep, but in a longitudinal direction. This latter was fixed, between the great and second toe, to the point of the sandal, which was curved upward (Figs. 1 and 2). The straps were often provided with ornaments. In addition to sandals, of elegant form, the Egyptian ladies wore gold anklets enameled in various colors. The legend as to the way in which Nitokris reached the throne of Egypt through the possession of the smallest and prettiest foot in the kingdom recalls our story of Cinderella. The Assyrians employed sandals with heel pieces and which were likewise provided with straps (Fig. 3). They wore, too, a long foot covering, recalling some of those of later times (Fig. 4). The Persians were fond of coloring their footgear saffron-yellow, and ornamenting it at the top. Among the Greeks, we find in addition to the ordinary sandals observed upon almost all the statues (Fig. 5), a half shoe with heel piece and tie (Fig. 6), and even a laced shoe, worn principally by women (Fig. 7). In the Tanagra clay figures this latter is colored red, with the sole bordered with yellow.

The foot coverings of the Romans (Fig. 8) were distinguished by the care employed in their manufacture and by their strength. Those of the soldiers were very heavy and provided with nails. The system of straps was arranged as among the Greeks. Shoes covering the ankle (Fig. 9) formed part of the costume of the senators. In the time of the emperors, red was employed by preference as the color for footgear.

Among the Byzantines, the world of fashion substituted leather or silk shoes for sandals. To these, the rich added silk stockings that reached the knees. Shoes embroidered with gold and ornamented with pearls were worn by persons of high rank.

The Germans, before the great emigrations of the bronze age, knew only the foot covering made of a single piece of leather and fixed to the foot by means of a strap passing through the edges (Fig. 10). When they employed skins for this purpose they turned the hairy side outward. In the third and fourth centuries, the leg was surrounded with bands that were kept in place by the straps of the foot covering (Fig. 11). This form of covering remained in use until the tenth century. It is to this epoch that belongs the German shoe (Fig. 12). Figs. 13 to 16 represent the shoes of the Carlovingian epoch, which were ornamented with taste. Fig. 17 shows a Norman shoe of the eleventh century.

The foot coverings of the flourishing age of chivalry had exactly the form of the foot and terminated in front in a small point. The material employed was fine leather, silk and even fabrics of gold, especially for the shoes of ladies. They were ornamented with pearls and provided with laces. Black, white, yellow and red were the colors preferred (Figs. 18 to 22). Although from the standpoint of taste we have no fault to find with the small pointed toe just mentioned, the same is not the case as regards those horrible shoes "à la poulaine" of the fourteenth and fifteenth centuries, which fashion wished to be ever longer and longer (Fig. 23). The points of these shoes were made of stiff material, or else were soft or were stuffed to keep them straight. They were sometimes provided with rattles. Sometimes, too, they were fixed to the knee or the girdle by a small chain. James I., king of Scotland, adopted the latter fashion. In order to prevent the points from being exposed to the mud of the bad streets of this epoch, shoe bottoms were invented that were held by straps. They were of wood covered with metal and sometimes also of leather, and ornamented with chased work (Fig. 24). These inconvenient points were a sign of nobility, and those who wore them did not wish to go without them even in time of war. At the battle of Sempach (1386), these points were not yet of iron. In case of necessity it was consequently possible to easily rid one's self of them; but, during the second half of the fifteenth century, the shoe was wholly of iron. Fig. 25 shows the foot of a Burgundian knight of the time of Charles the Bold. It was not till the beginning of 1480 that this fashion began gradually to wane. Since 1212 secular and ecclesiastical assemblies had tried in vain to check it. The little success that their tentatives met with is explained by the fact that the degree of nobility was measured, so to speak, by the length of the point. Thus, in the time of Philip the Handsome, the barons wore shoes two feet in length.—*La Science en Famille.*

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 13

Fig. 14

Fig. 15

Fig. 5

Fig 6

Fig. 16

Fig. 17

Fig. 18

Fig. 7

Fig 8

Fig. 9

Fig. 19

Fig. 20

Fig. 21

Fig. 22

Fig. 11

Fig. 10

Fig. 12

Fig. 23

Fig. 24

Fig. 25

FIGS. 1 AND 2.—Egyptian Sandals. FIGS. 3 AND 4.—Assyrian Sandals. FIG. 5.—Greek Sandal. FIG. 6.—Greek Shoe. FIG. 7.—Laced Shoe of Greek Lady. FIG. 8.—Roman Shoe. FIG. 9.—Shoe of Roman Senator. FIGS. 10, 11, AND 12.—German Shoes of the Bronze Age. FIGS. 13 TO 16.—Shoes of the Carlovingian Epoch. FIG. 17.—Norman Shoe. FIGS. 18 TO 22.—Footgear of the Age of Chivalry. FIG. 23.—Shoe "à la Poulaine." FIG. 24.—Same with wooden support. FIG. 25.—Iron Shoe of Burgundian Knight.

## MSS. OF THE NEW TESTAMENT.

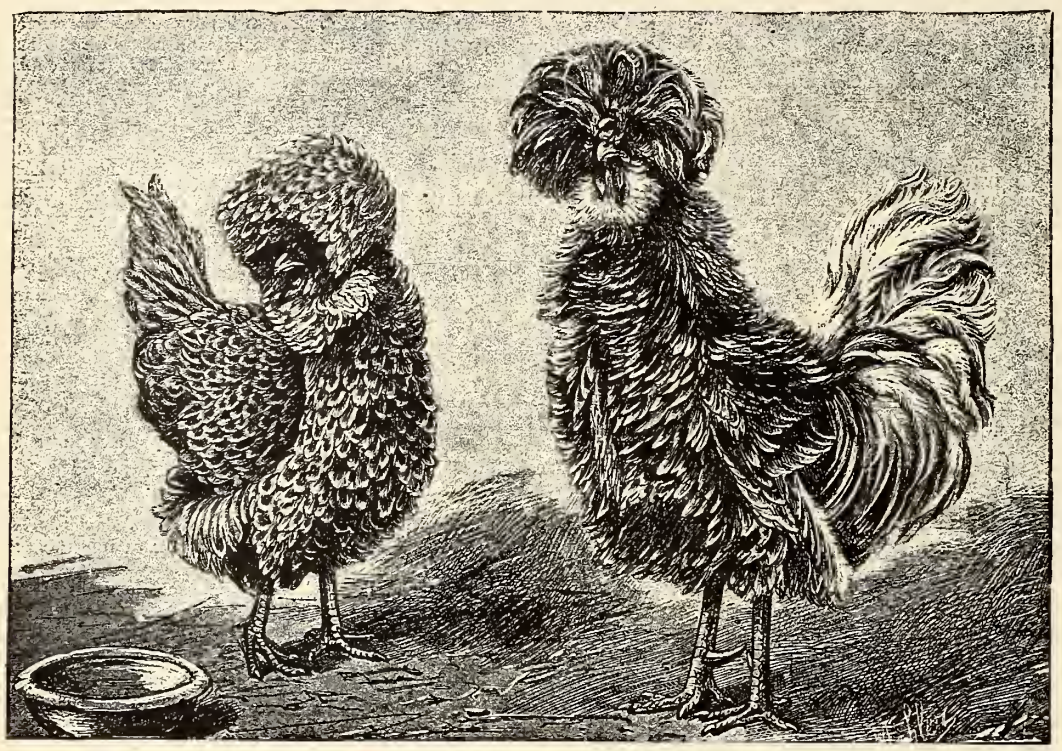
No fewer than 1,760 ancient manuscript copies of the New Testament in whole or in part exist, their abundance markedly contrasting with the small number which have come down to our own day of the classical writers. As no miracle has been wrought to preserve copyists from error, the last century added up 30,000 various readings in the New Testament manuscripts; and the present one has increased the number to 150,000. Some interesting particulars are given in the "Sunday School Teacher's Bible Manual" for December. Only the merest fraction of them are of any consequence; and their number, and the fact that they were made originally in different parts of the world and from a variety of manuscripts, enable Biblical students to detect and eliminate the errors and approximate to the original text more closely than if the various "readings" were fewer. This tedious but necessary work has been carried out with untiring energy. The New Testament manuscripts fall into two divisions: "Uncials," written in Greek capitals, with no distinction at all between the different words, and very little even between the different lines; and "Cursives," in small Greek letters, and with divisions of words and lines. Professor Roberts dates the change between the two kinds of Greek writing about the tenth century. Only five manuscripts of the New Testament approaching to completeness are more ancient than this dividing date. The first, numbered by Biblical critics A, is the Alexandrian manuscript. Though brought to this country by Cyril Lucar, patriarch of Constantinople, as a present to Charles I., it is believed that it was written, not in that capital, but in Alexandria; whence its title. It is now dated in the fifth century, A.D. The second (known as B) is the Vatican manuscript. It has been in the Vatican library from 1475 or an earlier period, but not till A.D. 1859 was an edition of it published, and that one, by Cardinal Mai, when issued, was uncritical and of little value. But in 1868 a facsimile of it came forth, so that now it is fully accessible to scholars. The Vatican manuscript dates from the middle of the fourth century, if not even from an earlier period. The third (C), or the Ephraem manuscript, was so called because it was written over the writings of Ephraem, a Syrian theological author—a practice very common in the days when writing materials were scarce and dear. It is believed that it belongs to the fifth century, and perhaps a slightly earlier period of it than the manuscript A. The fourth (D), or the manuscript of Beza, was so called because it belonged to the reformer Beza, who found it in the monastery of St. Irenæus, at Lyons, in A.D. 1562. It is imperfect, and is dated in the sixth century. The fifth (called Alpha) is the Sinaitic manuscript obtained in 1844 by Professor Tischendorf from the monks belonging to the convent of St. Catherine, on Mount Sinai. It contains the whole New Testament. It is believed that it was made in the fourth century, and its value to the Biblical critic is very great. Any other "uncial" manuscripts that exist are only fragmentary. The cursive manuscripts, though numerous, are of too late a date to stand on the same level for critical purposes as the "uncials." It is possible indirectly to gain access in whole or in part to the readings in manuscripts which have perished. There were early versions of the New Testament in different languages, such as the Syriac, etc. In many cases these were made from manuscripts not now existing, but the translation shows what the original must have been. Christians of the early ages, like those now living, were accustomed formally to quote or informally to allude to particular Scripture passages. When there is reason to believe that it was done with precision, it is easy to ascertain from their writings what the original reading was in the manuscript of the New Testament in their possession.—*Public Opinion.*

## THE BREEDS OF FOWLS.

THERE has just appeared at the book house of Emile Deyrolle a work on the "Breeds of Fowls," by Mr. La Perre de Roo, giving a complete history and description of all the breeds of fowls known up to the present time, and they are numerous.

The domestication of the barnyard fowl dates back to remote antiquity. Darwin, says the author, thinks that he is able to fix the time of the introduction of it into Europe in the sixth century before Christ. Formerly there was but a single species of wild cock known, but now we know four very distinct and characteristic species, viz., the Bankiva cock (*Gallus Bankiva* or *ferruginea*), the Lafayette or Stanley cock (*G. Lafayettii* or *Stanleyi*), the forked cock (*G. furcatus* or *varius*) and the Sonnerat cock (*G. Sonneratii*). It is especially in the vast forests and the mountains of India and other countries of Asia that we find the various species of wild fowl in large numbers. They are met with also in the wooded portions of the mountains of Java, Ceylon, etc.

To return to the work above mentioned, let us say that it contains a description of all the breeds known, their history, particular study of the male and female, their habits, characteristics, etc. All the varieties, moreover, are studied and discussed. The work is illustrated with 121 figures in the text and 32 plates, both in black and colors, giving the principal types. We give herewith two specimens of these engravings, representing the cock and hen of the frizzled breed of Chile, the cock and hen of the breed known as *sabot*, and the cock and hen of the breed of Nangasaki, variety cuckoo. We are happy to make the appearance of this very complete work on the breeds of fowls known.—*Le Naturaliste.*



COCK AND HEN OF THE FRIZZLED BREED OF CHILE.

## VEDALIA CARDINALIS—A TRIUMPH OF SCIENTIFIC METHOD.

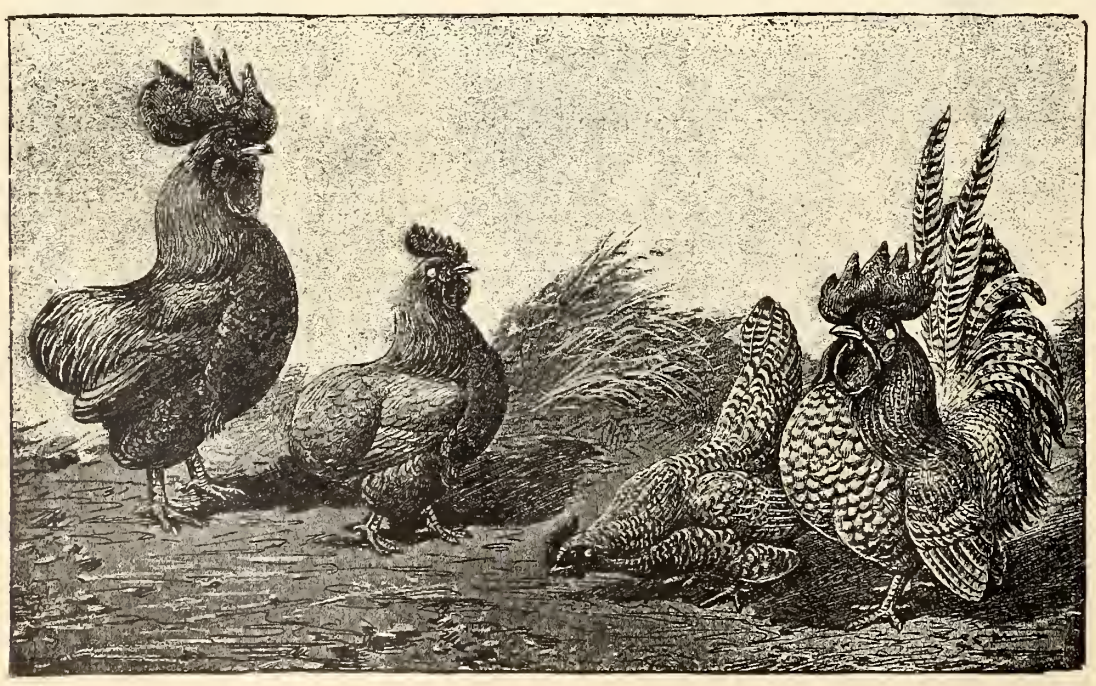
SOME three or four years ago California orange culturists were almost in despair at the ravages in their orange groves of an insect known variously as the Fluted Scale, the White Scale or the Cottony Cushion Scale (*Icerya Purchasi*). For a time it looked as if orange culture would have to be abandoned in California, but just in the nick of time Prof. Riley, Government Entomologist, came to the rescue. He had, after careful investigation, definitely ascertained that the scale in question was a native of Australia, and that it was not practically injurious there. Here was the clew, and it was skillfully followed up. Long correspondence with Australian entomologists, and the dispatch of a carefully instructed agent to that country, resulted in the discovery of the parasite now so well known as *Vedalia cardinalis*, which keeps the Cottony Cushion Scale in subjection in its native home. When the scale was inadvertently brought over to California upon Australian oranges, *Vedalia* had been left behind, with the result that its host, the scale, had multiplied without restraint, as commonly happens when an insect is imported without its natural checks. Forthwith a large shipment of living Vedalias was made from Australia to California, and the surprising result is known to everybody. Within a few months the scale was obliterated, orange culture was again on its feet, and *Vedalia* had become a household word in California.

The experiment was successfully repeated in the Hawaiian Islands, where also the scale threatened to extinguish orange raising, and last fall a special commissioner from the Cape of Good Hope arrived in the United States, with the purpose of securing a supply of Vedalias for use in his country, where the scale was menacing orange culture. He was given every assistance possible, both at Washington and in California, and went home with a good stock of the insects. One package was kept upon ice during the voyage (the method adopted in the original importation into California) and a second was left open, that the insects might be fed *en route*.

The special commissioner alluded to, Mr. Thos. A. J. Louw, has recently reported to the Department of Agriculture the entire success of this latest colonization of *Vedalia*, the insects having reached the Cape alive and well, and been distributed to various infested localities, and there is every reason to believe that they will make as rapid and effectual a clearance of the scale in South Africa as they have in California and Hawaii. In closing his letter to Assistant Secretary Willets, Mr. Louw says:

"While thanking you again for the kindness displayed toward me, may I request you also to convey to Prof. C. V. Riley my extreme obligations for the service rendered by him to me, and which I assure him will ever be appreciated by me."

Vedalia is rather a pleasing name, and it is not surprising that there should be as a substantial commemoration of this entomological romance a Cathryn Vedalia Riley, the youngest of five girls, who form part of a happy family at the well-known entomologist's home at Sunbury, in Washington.—*Meehans' Monthly.*



COCK AND HEN OF THE BREED CALLED SABOT.

COCK AND HEN OF THE NANGASAKI BREED; VARIETY COUCOU.

## ANTARCTIC SEALS.

By WILLIAM S. BRUCE, Naturalist to the Antarctic Expedition, 1892–93.

AFTER a period of dormancy extending over more than half a century, the Antarctic is again being opened up to scientific investigation and to commerce. Scotland and Norway sent out five vessels last year, and Norway is again to the fore this year; New Zealand also is said to be eager to join the chase. It seems also likely that work of a more purely scientific nature will be undertaken in the Antarctic during the coming year. Some readers may, therefore, be interested to hear something about the southern seals, which differ very considerably from those of the north.

In the Antarctic only two of the great families of seals are represented; they are the sea lions and sea bears, or eared seals (*Otariidæ*), and the more specialized true seals (*Phocidæ*); the intermediate family of walruses (*Trichechidæ*) being entirely absent. In recognizing nine different species of *Otariidæ*, Mr. J. A. Allen divides the family into five species of sea lions and four species of sea bears, and three of these five sea lions and three of the four sea bears belong to southern seas. The true seals he divides into sixteen species, and five out of these sixteen species of true seals belong to southern seas. It is from the sea bears of the *Otariidæ* family that ladies' sealskin jackets are made; the under skin, to which the long, rigid hairs are attached, is shaved off, and the long hairs fall out, leaving the upper skin with the soft under fur alone. The Falkland Islands fur seal (*Arctocephalus falklandicus*) is noted, however, for the evenness, shortness and elasticity of the fur. The fur is soft enough to wear as a rich fur without the removal of the longer hairs, which are always removed in the other fur seals. The skins of all other seals, whether sea lions or true seals, are used for making leather. The tens of thousands of seals that are slaughtered annually off Newfoundland and Greenland supply us with patent leather, and similarly the twenty to thirty thousand seals' hides that the Dundee whalers brought home from the Antarctic last spring will eventually be used for the same purpose. Crocodile leather, which we see in such vast quantities nowadays, is also said to be largely made from seals' skins. Besides skins, seals provide a great quantity of oil. During the recent trip to the south, the Dundee vessels secured from seven hundred to one thousand tons of seal oil; this is largely used in the jute manufactory for moistening the fibers, and this fact possibly accounts for Dundee not only being "Juteopolis," but also practically our only remaining sealing and whaling port. But now mineral oils, which are so cheap, are taking the place of animal oils in the jute factory, as they have in other branches of industry, and the masters and owners of sealers and whalers are beginning to think it hardly worth while fishing seals and whales for oil alone.

Concerning the sea bears, or fur seals, and the sea lions, or hair seals, of the Antarctic very little is known. The former have an abundant soft, silky under fur, are black when young, and ultimately yellowish or whitish-gray color; and the latter, the sea lions, have no under fur, but only coarse, hard, stiff hair; they are yellowish or reddish-brown, dark when young, but become lighter as age advances. The groups generally live apart, but have the same geographical distribution. They are gregarious, polygamous, and the males are from three to five times as large as the females. They differ very markedly from true seals in having the power to turn their hind limbs forward, and thus use them for locomotion on land; the presence of a small external ear is another characteristic. Of the Alaskan seal herd, Mr. H. W. Elliott gives the following graphic description, which may be extended to the southern herds: "The fighting between the old males for the cows is mostly—or, rather, entirely—done with the mouth. The opponents seize one another with their teeth, and then, clenching their jaws, nothing but the sheer strength of the one, and the other tugging to escape, can shake them loose, and that effort invariably leaves an ugly wound, the sharp canines tearing out deep gutters in the skin and furrows in the blubber, or shredding the flippers into ribbon strips.

"The bulls generally approach each other with comically averted heads, just as though they were ashamed of the rumpus which they are determined to precipitate. When they get near enough to reach one another, they enter upon the repetition of many feints or passes before either the one or the other takes the initiative by gripping. The heads are darted out and back as quick as a flash; their hoarse roaring and shrill piping whistle never cease, while their fat bodies writhe and swell with exertion and rage; furious lights gleam in their eyes; their hair flies off into the air, and their blood streams down. All this combined makes a picture so fierce and so strange that, from its unexpected position and its novelty, this is one of the most extraordinary brutal contests man can witness."

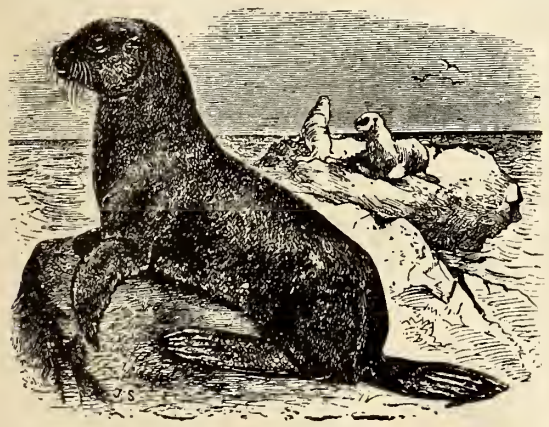
Mr. J. A. Allen has done much to simplify the classification, but the utmost confusion exists in most of the attempts made to classify them. Many attempt to divide them into a great many genera, but Mr. Beddard considers that if "the genus be split up at all it should be divided into *Otaria*, containing only the Patagonian sea lion (with its various synonyms) and *Arctocephalus*, comprising all the other species." The latter have narrower and more pointed noses and longer ears, besides other anatomical differences. The most notable is the Patagonian sea lion (*Otaria jubata*), which is represented by a living specimen in the gardens of the Zoological Society. Besides inhabiting Patagonia and the coasts of South America, this remarkable animal is also found in the Falklands. As is well known to frequenters of the Zoological Gardens, this animal in captivity becomes remarkably tame,

and even shows great affection to those who attend to its wants. The Cape sea lion (*Otaria pusilla*) inhabits the islands south of Africa. A living representative of this species is also to be seen at the society's gardens, its pond being close to that of the public favorite; it is smaller than the Patagonian sea lion, and is less familiar to the public. The Australian seas have also a representative. Strictly speaking, perhaps one should exclude most of the *Otariidæ* from Antarctic fauna, but in a wide sense most of the localities above mentioned are spoken of as being within the sphere of the Antarctic regions. In places such as South Georgia, the South Shetlands, and the island of Mas-a-fuero, near Juan Fernandez, and other localities where these animals abounded, they now no longer exist, on account of the excessively greedy ravages of man.

Formerly there was an extensive fur seal trade in South America and the Falkland Islands, in Australia, and in South Africa; but now there are so few seals in these localities that they are not worth hunting. In the Falkland Islands, however, it is pleasing to hear that the fur seals are now increasing in numbers, the most rigid protection being enforced; but with no telegraphic communication, and with no railways in the islands, poachers are said often to be able to secure a considerable amount of booty and make off before the authorities are able to enforce the law. In islands lying within New Zealand or Tasmanian waters a close season has also recently been proclaimed.

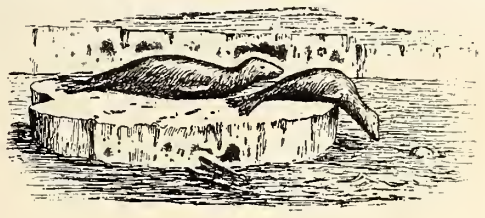
The true seals are represented by five species and two genera (*Allen*); they are the white Antarctic seal (*Stenorhyncus carcinophaga*), sometimes called the "crab eater seal" (for what reason it is difficult to say); the sea leopard seal (*Stenorhyncus leptonyx*); Weddell's false sea leopard seal (*Stenorhyncus Weddellii*); Ross' large eyed seal (*Stenorhyncus Rossii*); and, lastly, the monster seal known as the "sea elephant seal" (*Cystophora elephantina*). Skulls, and in some cases complete skeletons, of most of these seals are exhibited in the British Museum, South Kensington, and the College of Surgeons Museum, as well as in some of the provincial museums; one or two stuffed specimens also occur.

Of these five species the first two, the white Antarctic seal and the large sea leopard, are most abundant, being found in great numbers on the pack ice. The beautiful white Antarctic seal must surely be a descendant of Rudyard Kipling's great white seal, which roamed the world around to escape cruel and relentless man. Its coat is of a beautiful creamy white, resembling that of the polar bear, but short haired, the color becoming somewhat more intense along the back. Looking at the animal face to face, its coat appears silvery, and the dorsal stripe almost vanishes; but when looked at from behind it assumes a deeper cream color, and the broad stripe along the back becomes quite prominent. The full grown animal may attain a length of about seven feet. The sea leopard is a very striking animal, and, with the exception of the sea elephant, is the largest of all seals. In the recent Antarctic expedition (1892–93) some were met with that measured over thirteen feet in length. Their coat is a dark brown-gray and mottled, becoming paler gray below, and in some cases almost black on the back. A rather striking and not altogether inappropriate name was given to these seals by the sailors in the recent cruise; they called them "serpents," and they do really often look very serpent-like with their long necks and green eyes. Weddell's false sea leopard is more rarely met with, and is nearly as large as the sea leopard, but less shapely and more thickly blubbered; its head is smaller, fore flippers very small, coat more woolly and of a dark brown-gray. Ross' large eyed seal is a beautiful creature, with bright and affectionate eyes; in form and size it is very like the white seal, but its coat is of a beautiful mottled gray, darker toward the back. The sea elephant is the largest of all seals, attaining the enormous length of twenty feet. It is a near relative of the crested seal of the north, and is also found along the Californian coast. The male has a somewhat elongated snout, hence the origin of its name. The females are about one-third less in size. The males are said to come ashore on the Shetlands about the end of August and beginning of September, and in the first part of October are followed by the females. The males are very fat when they first arrive, but get lean toward the end of December, when they leave the islands. Another herd was said to visit the islands about the middle of January—when they renew their hair—and still another in March; by the end of April all returning to the sea. They are very difficult to kill, but, like the other species, allow themselves to be approached even with a club. This seal used to be highly valued for its blubber; in 1821 and 1822 alone as much as nine hundred and forty tons of sea elephant oil was taken from the South Shetlands; and it may here be mentioned that during these same two years at least three hundred and twenty thousand fur seals were also taken from these islands.



THE PATAGONIAN SEA LION.
(*Otaria jubata.*)

It was with the skins and blubber of the first two species of these true seals that the Scottish and Norwegian crafts loaded themselves last season. The slaughter was revolting to one unused to it; within two minutes the seal is brained, deprived of its skin, and its gory corpse left writhing on the snow. Early in the morning, when the sun is beginning to make more or less impression by his rays, and the seals are coming out of the water on to the pack, all hands are ready to take part in the fray. The sails are stowed; the skipper sits in the crow's nest from early in the morning till late in the evening; the two engineers, relieving one another, take charge of the engines; the cook or the steward is on the lookout; some non-combatant takes the helm; all the rest are away after plunder in the boats. Now a full boat is making its way to the ship. She steams toward it. As she nears, the engines are stopped and the boat glides alongside. The cook or the steward rushes from the look-out, the helmsman from the wheel, one working the steam winch and the other unswitching the skins, while the



SEA LEOPARDS ON PACK ICE.

boat's crew swallow a hasty meal. Their boat being unloaded, they are off again for another fill. Another boat is seen approaching, and away the ship goes again, dodging this piece of ice, charging that piece with her sturdy bows, boring away where the ice lies closely packed, rounding this berg, and on to the next, until she reaches the boat, which is down to the gunwale in the water, with its crew cautious, plying their oars as they lie crouched upon their bloody load. So it goes on from day to day; "hay is made while the sun shines," and the pile of skins and blubber rises high upon the ship's deck. Then comes a gale of wind, accompanied by fog, sleet and snow, and the ship "lays to" under lee of a stream of pack ice or a berg. The deck becomes busy with life; the blubber is "made off," and put into the tanks, and the skins are salted. During such inclement weather the seals do not seek the ice, but may be seen swimming about in the water. When the gale is over, at the end of two or three days, the next few days of calm weather are again taken advantage of to continue the slaughter. Thus the periods of gales and calms, which alternate in this part of the world, come in conveniently for sealing; the produce obtained in the calm weather being "made off" during the gales.

Concerning the habits and anatomy of these seals much remains to be investigated. During the summer months (December, January, February), as has already been stated above, the first four are to be found on the pack ice, where, during the day, they bask in the sun, digesting the meal of the previous night. Their food consists of fish or shrimp-like crustaceans, and sometimes of penguins. Stones, which were probably first swallowed by the penguins, may also be found in their stomachs. They become so lazy with sleep that a man may dig them in the ribs with the muzzle of his gun, and wondering what it is disturbing their slumbers they raise their head, which quickly falls pierced with a bullet. There may only be one seal on a piece of ice, which is usually the case with the sea leopard seals, but the smaller kinds lie in half dozens and tens, and as many as forty-seven were seen on one piece during the recent cruise. On one occasion several seals were found upon a tilted berg; so high was the lowest edge above the surface of the water that the boat's crew with difficulty clambered up and secured their prey. Yet the seals must have made a leap from the water on to this their last resting place. December seems to be their mating season; about that time they are in very poor condition, and very much scarred. The females appear to be as freely scarred as the males. It was also noted that the seals were most numerous where the water was bluest and clearest—this, in all probability, meaning that they were more numerous on the outside of the pack, since the muddy olive-brown color of the water, due to *corethron diatoms*, seen so frequently in the south polar seas, seems to indicate proximity to the main pack. The males appear to be as numerous as the females, and, in the case of the sea leopard seal and Weddell's seal at least, the males are perhaps rather smaller than the females.

They move swiftly through the water, and can throw themselves eight or nine feet above the surface, covering distances of fully twenty feet. Their moaning in the gloaming of a calm gray day comes as a weird sound through the haze, and makes the icy solitude more lonely, adding awe to a scene already full of fascination! They seem to wonder at man, and not recognizing him as an enemy, they allow him to approach, only to be laid low with club or bullet. It is a matter of great regret that they should be so indiscriminately massacred; there is no regard for sex or age, and even females heavy with young do not escape. If fleets of sealers continue to visit the south, there should be some law of protection, otherwise there is no doubt that, like the southern fur seals at the beginning of the century, these Antarctic seals will be exterminated.—*Knowledge.*

## THE PECTEN OR SCALLOP.

By NICOLAS PIKE.

PECTENS are found the world over; and 176 species have been described and figured now existing and many fossil ones. Yet few know more of them than the form of the shell and the luscious morsel it contains. The uses of the pecten are and have long been many and varied.

The "scallop shell" has had world-wide fame since the days of the crusades. The pilgrims to the Holy Land were recognized by one of these shells fastened on the front of the hat and one or more on the cloak, as ensigns they were warriors of Christ, to free the sacred soil from paganism. A shell may still be seen on many a coat of arms dating from that period. How fruitlessly such wealth of life and treasure was spent history's pages tell; but the scallop lives on and flourishes through all the centuries. The shell used was the *P. jacobeus*, abundant on the shores of the Mediterranean.

Not alone was it a Christian emblem, but is said to have been employed as a drinking cup celebrated in Ossian's "hall of shells." This is supposed to have been the *P. maximus*, common on the shores of Great Britain and Ireland. In some countries the poor people use the large shells as plates. In restaurants in Paris delicate preparations of mushrooms are served in them, and in England oysters are scalloped in them. I once saw them in Gallicia, Spain, used for side dishes filled with fish paste and garlic.

The shells of most of the species are beautiful when well prepared; those of the Indian Ocean are said to be the handsomest. Some have become articles of commerce and all kinds of fancy bags, baskets and boxes are ornamented with them. Some of the shells are large, stout and heavy, while others are thin and transparent.

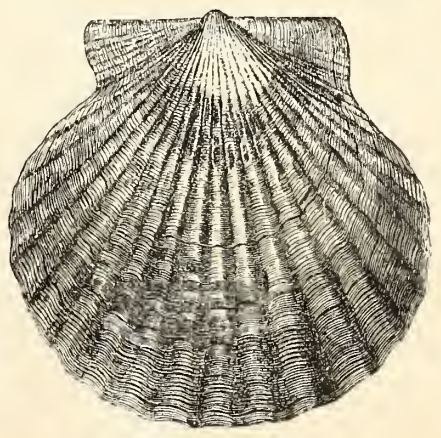
The pecten of our coasts is the *P. irradians*, which grows to a fair size, and is much sought after for its strong muscular abductor muscle, familiarly known as "scallops." Though this muscle is the only part of the animal sold as food here, yet the whole pecten is credited as being good and wholesome, several species being eaten.

The scallop is very abundant on the shores of Long Island, also is found from Cape Cod to Cape May, but little of its life history is known generally.

Unlike the oyster, which is a complete fixture to its bed, the pecten is perfectly free, and shifts about from place to place. It has the power of making frequent and sudden contractions of its muscles, by which means it moves rapidly through the water, making its capture difficult. This movement is made by quickly closing its half open valves and forcibly expelling the water, and is backward, by a sort of reaction. This action, repeated many times, compels the animal to move in spite of itself, enabling it to avoid danger and reach the desired spot. Some naturalists assert that when raised to the surface of the water, the pecten half opens its shell and the upper valve serves the purpose of a sail (?) Aristotle first noticed that it had the power of leaping when out of the water.

Miss Catlow mentions that a basketful of common pectens placed near the water was speedily emptied, by the individuals springing from their confinement to their native element. M. Lesson immersed a basket of pectens in the sea, the water coming to within six inches of its rim. He says, the individuals which formed the superior layer, constrained in their movements by those that were beneath, after many efforts succeeded in leaping from their prison. No sooner did they fall upon the water, than, by striking their valves rapidly together, they ran or rather skipped a few seconds upon the surface, and then sunk to the bottom. In this way all the contents of the basket disappeared in fifteen minutes. The Rev. D. Landsborough observed young pectens when less in size than a sixpence swimming in a pool of sea water left by the ebbing tide. Their motion was rapid and zigzag, and it seemed to him that the sudden opening and closing of the valves gave them the power of darting like an arrow through the water. One jerk carried them some yards and then by another jerk they were off in a moment on another tack.

In my studies of this curious animal I found it very difficult to pursue them on account of their habits. They throw off the spat like the common oyster, only unlike it, the growth is rapid. After the females have done spawning they frequently bury themselves for some days in the sand. The young spat seem to have the power of guiding themselves without difficulty till they come in contact with some substance, generally the *Zostera marina* or eel grass, where they attach themselves by spinning a byssus, and in a few hours a thin coating is secreted which covers the little animal and is as transparent as glass. In five or six days the shell is completed so as to give protection to the little animal, when he drops off and commences the battle of life on his own account. They are now the size of a pea,



PECTEN IRRADIANS.

but their growth is rapid and they become very active, darting about for food. Those I carefully watched in an inclosure in Huntington Bay grew so rapidly that in seven or eight weeks they were as large as a silver dollar and ready for the market.

A favorite location of this animal is where the water is shallow, generally near the banks of rivers and bays opening out to the sea, where the bottom is sandy and there is a good growth of eel grass. The food of the scallop is similar to that of the oyster, and minute diatoms are found in the stomachs of the young when ten days old. At the approach of cold weather the scallop goes into deeper water and often buries itself in the sand, as some were brought up in my dredge I had unearthed in the latter part of November.

The scallop breeds from June to the latter part of

August. This mollusk has great tenacity of life, as the following shows. While studying at Huntington one summer, I captured quite a number, as I am very partial to shell fish food. Some of them were cooked and eaten, while nearly half were very carefully laid away in a cool place under the stone steps of my house, and were forgotten. A handful of seaweed had been placed over them, and there they remained for over ten days. When brought out they seemed all right and in good condition, but to make sure I took the basket to the shore to wash them in the salt water. I left them soaking in it for a short time, and when I returned, to my surprise and disgust they had all managed to escape but one or two, and they finally leaped out, skimmed along the surface a few feet, and then dropped quietly out of sight. It requires some skill in the handling of these bivalves, and if you catch them by the naked hand, there is danger of being well paid for your temerity, for they often nip the flesh so as to bring blood and cause sharp pain.

The animal is shaped to the shell, "mantle freely open, with pendent margins, the inner like a curtain finely fringed; at its base a row of conspicuous round ocelli, surrounded by tentacular filaments, gills exceedingly delicate, crescent shaped, quite disconnected posteriorly, having separate excurrent canals; lips foliaceous; palpi truncated, plain outside, striated within; foot, finger-like, grooved, byssiferous in the young."

It is singular that this animal has been so neglected by naturalists, as it has become quite an important article of fish food, and finds a ready sale in our markets. It is wholesome and nutritious as the oyster is and I believe could be as easily propagated as that succulent bivalve. The large bays and rivers of Long Island Sound are admirably suited for this purpose. Thousands upon thousands of bushels could be raised yearly with very little outlay. It is not generally known that the whole animal is edible, but I find it was used for food at a very early period. What quantities of good food are daily thrown away and nothing utilized but the large abductor muscle!

Not alone is there waste in throwing away the pecten, but the small use made of other shell fish. In London over 1,000,000 quarts of mussels, 4,000,000 quarts of periwinkles; and 750,000 quarts of cockles are sold yearly. The two latter are not of much account here, though they could be cultivated. Of mussels we have the finest kinds in abundance, and their fisheries only want development. How many half starving families who cannot afford to buy meat could get good, wholesome and cheap food if the mussel was better known!

[Continued from SUPPLEMENT, No. 942, page 15062.]

## ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

*Lectures I. and II.*

THE question now arises, How are these instruments calibrated? To describe the methods at length would demand more than a single lecture, and the reader may well consult the papers to which reference is given.† It should be stated, however, that the calorimetric method of Violle has enabled the melting points of general refractory metals, such as silver, gold, palladium and platinum, to be determined, and these have afforded a secure basis for the work of calibration. The classical work of H. St. Claire-Deville, and Troost with the air thermometer, to which reference has already been made, has rendered splendid service by enabling us to measure accurately high temperatures and to state the results in the degrees of the ordinary thermometric scale.

The most useful data to bear in mind are:

| | |
|---|---|
| The melting point of zinc | 415° C. |
| " " " aluminum | 625° |
| " " " silver | 954° |
| " " " gold | 1,045° |
| " " " palladium | 1,500° |
| " " " platinum | 1,775° |

By suitably protecting either the thermo-couple or the Callendar resistance coil (Fig. 5), and surrounding them by masses of any of these metals, it is not difficult, provided care be exercised, to determine the points at which they either "freeze" or melt, and thus to calibrate the instruments, but such experiments demand much skill and familiarity, both with working at high temperatures and in manipulating the precious metals.

There are various other pyrometers, but they are better suited for industrial work than for the purposes of research, and will therefore not be described here.

Of all the varied pyrometers, much may be said in favor of the electrical ones, which involve the use of the galvanometer. It will have been evident that, in the case of either of them, the spot of light from the mirror may be received on a sensitized plate, and very slight variations of temperature can then be recorded automatically. As regards the two electrical methods, much advantage may be claimed for the one that depends on the use of a thermo-couple, which is itself very small, and if injured, can be readily replaced. It can, moreover, if suitably protected, be placed in the midst of a few grammes of metal which is being submitted to thermal treatment. The little mass of metal may not be heated beyond redness, or the operation may involve its fusion and volatilization, but a permanent record can be obtained of minute changes in the behavior of the metal, if they are marked by the evolution or absorption of heat such as accompany the passage of a metal or alloy from a normal state to an allotropic one. The various phenomena of fusion and solidification can also be faithfully recorded, whether they occur either in the center of a twenty-ton ingot of steel or in a tiny mass of gold. On the other hand, the little pyrometer may be placed in the blast mains of an iron or steel works, and will furnish the manager with precious information and a trustworthy record of the variations of temperature in the torrents of hot air which pass over the thermo-couple on the way to the seething contents of the furnace.

It remains to be seen what use may be made of this powerful weapon of reasearch in conducting investigations into the nature of alloys.

In employing the thermo-couple for studying the molecular grouping of alloys, it is necessary to bear in mind what would happen if an ordinary mercurial thermometer is plunged into water which is losing its heat to a cold environment. The mercurial column would, as is well known, fall until the water begins to freeze, and then the mercury remains steady until the whole of the water is frozen. The latent heat of the water is gradually liberated during the solidification of the forming ice, and the thermometer ceases to indicate a fall in temperature until the work of solidification is complete. The case is precisely the same when a metal is cooled down to its freezing point. Suppose the thermo-couple is in connection with the autographic recorder (Figs. 6 and 7), and is suitably protected—though this is not absolutely necessary—and is plunged into the midst of a little mass of fluid gold—some 30 grammes will suffice—which is being slowly cooled. The photographic curve registered by the recorder will be that shown in Fig. 8. Assume

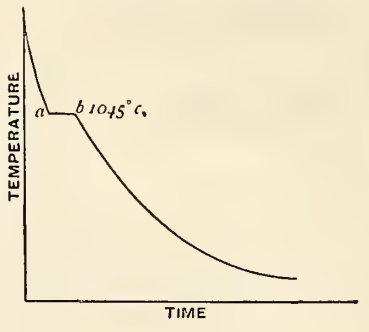



FIG. 8.

that the initial temperature of the cooling mass of gold is 2,000°, the temperature will fall, and the curve registered on the sensitized plate by the spot of light will, when the temperature of 1,045° is reached, suddenly become approximately horizontal, as at A, and will remain horizontal until the mass of gold is solid, and then, but not until then, it will resume its downward course to the point at which the little mass reaches the atmospheric temperature. The same effect would be produced if the thermo-couple were placed in any other metal—lead, silver, platinum or palladium—but in the case of silver and lead, the couple must be protected by clay from the direct action of the metal.

Hitherto we have only considered the case of a pure metal, but directly the mass is alloyed with even a minute quantity of another metal quite a different set of molecular conditions is established, respecting which the autographic curves enable most precious information to be gathered. In fact, the purer the metallic mass is, the sharper will be the angle made by the horizontal portion of the curve, *a*, *b*, with the portions above and below it. The presence of an added element, even though its amount be apparently insignificant, is quite sufficient to destroy the sharpness of the freezing point of any metal which has as yet been examined. If the added metal is present in a very small quantity it apparently remains free, and usually lowers the freezing point of the mass, as will be hereinafter explained, but when a certain proportion of the added metal has been reached, it unites with a portion of the mass, and certain alloys, or groups of alloys, are formed which fall out of solution as the mass cools, and the result is to change the nature of the cooling curve, rounding its angles, and, in extreme cases, obliterating the horizontal part altogether.

Such an extreme case is presented when two-tenths per cent. of aluminum is added to gold (Fig. 9). The

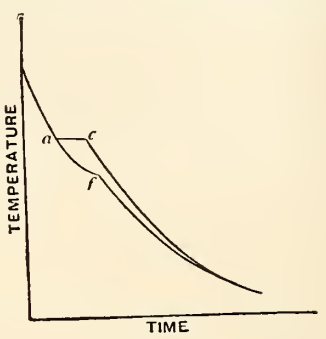



FIG. 9.

horizontal part of the curve is practically obliterated, that is, there is no true freezing point. The normal curve for freezing gold would have followed the line *a*, *c*, but the curve of gold, with two-tenths per cent. of aluminum is that shown at *a*, *f*, with only a faint indication of the freezing of the mass, as a whole, at *f*.

In this experiment the addition of only a small quantity of an added metal has been considered, and that from a somewhat limited point of view. The conditions are widely different when the added metal forms a large proportion of the mass to which it is added. The case of the aluminum gold alloys is very instructive. Suppose the apparatus shown in Figs. 6 and 7 to be so arranged that a series of cooling curves could be taken of alloys, in which the amount of aluminum added is considerable. Starting with pure gold, having a freezing point at 1,045°, successive additions of aluminum lower the point and destroy the yellow color of the gold, until the alloy containing 90 per cent. of gold and 10 per cent. of aluminum is reached. The freezing point of this alloy is 628°, or 417° less than that of pure gold, but then with further additions of aluminum the curve turns, the freezing points begin to rise, and when the amount of aluminum reaches 21·6 per cent., the freezing point is actually a few degrees higher than that of gold itself, and the alloy is a brilliant ruby color. After this point is passed, successive additions of aluminum again lower the freezing points, and they appear to be lowered gradually until the freezing point of pure aluminum is reached.

The case of the aluminum-antimony series, investigated for Dr. Alder Wright by the author, presents a similar case. Dr. Wright observed that the melting point of the alloy, containing 18·7 per cent. of aluminum and 81·3 per cent. of antimony, is considerably higher than that of its least fusible constituent, the aluminum (625°). Accurate measurement by the aid of the curves obtained in the way which has been already indicated showed that the alloy, Al Sb, has a freezing point of 1,050°, or no less than 425° higher than that of aluminum. This aluminum-antimony alloy behaves like many true chemical compounds, stibnite ($Sb_2S_3$), for instance, the melting point of which is about 530°, though its constituents, sulphur and antimony, melt at 115° and 335° respectively.

In the case of most alloys, as the mass of the melted alloy cools down, groups of alloys, which are atomically definite in composition, appear to fall out of solution, just as in a cooling mass of granite, atomically definite groups of minerals fall out, the mica and the feldspar, tourmaline, or whatever the grouping may be, but the fluid mass which remains need not be, and probably is not, definite in composition. The silver-copper series presents an excellent case in point, and so do the alloys of lead and tin, and it is satisfactory that this autographic method of recording the cooling of a mass of alloyed metal enables the whole history of the case to be accurately traced. Turn, for instance, to the tin-copper series which comprise, industrially, a most important group of alloys. Alfred Riche * determined some of their melting points twenty years ago by the aid of a thermo-couple, which makes the hesitation of experimenters to employ thermo-couples in such investigations the more remarkable, and, I may add, my own tardiness inexcusable. He considered that Su $Cu_3$ and Su $Cu_4$ alone possess respectively a single definite freezing point. Mr. A. Stansfield, working in the author's laboratory, finds that all the tin-copper alloys appear to have two solidifying points, while some appear to have three.

The bismuth-copper series yield very interesting and unexpected information when examined by this method.† It appears that however small the amount of bismuth alloyed with copper may be, a certain proportion of the bismuth always remains free and does not unite with the copper at all. The cooling curve of any copper-bismuth alloy will, therefore, show at least two freezing points, the lower of which always closely corresponds with the freezing point of bismuth. The general nature of these curves is shown in Fig. 10, in

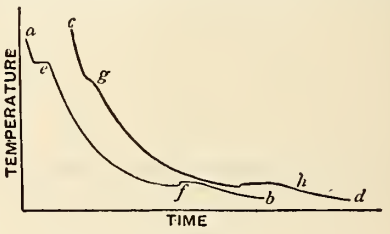



FIG. 10.

which A, B, is a cooling curve of molten copper, containing about ten per cent. of bismuth, while C, D, represents copper containing 30 per cent. of bismuth. It will be seen that there are two solidifying points in each, at E, F, and G, H, respectively, the points, F and H, being at the same temperature (268°), and are due to the solidification of the free bismuth.

One other curious property of metals may be well studied by the aid of this method of obtaining autographic cooling curves. It is well known that certain metals will, if slowly cooled, pass below their freezing point without actually becoming solid, and that when solidification does occur, the liberation of the latent heat of fusion, in some cases, reheats the mass to the melting point, and causes it to glow vividly even though it had previously fallen below redness. Pure gold and silver present such a case. It is more difficult to observe in the case of copper, but, with care, the occurrence of "surfusion," as it is called, may readily be detected in an autographic curve. Fig. 11 presents a

FIG. 11.

case in point. It was obtained from a small mass of very pure melted copper, into which a thermo-couple protected by clay was placed. It will be observed that the curve falls in the ordinary way from A to B, but that at B there is a depression, showing that the temperature fell *below* the actual freezing point, which is marked by the horizontal part of the curve, B C.

The peculiar behavior of certain metals which absorb gases and release them during cooling may also be well studied by the aid of the recording pyrometer.

It is now well known that very complicated changes may occur in the molecules of even solid metals, and the new pyrometric methods enable these changes to be studied with facility. The molecular changes which occur in solid metals are of three kinds:

1st. The grouping of the constituent metals of an alloy may be rearranged.

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† Roberts-Austen, "Proc. Inst. Civil Engineers," vol. cx., 1892. (Violle) "Comptes Rendus," vol. lxxxv., 1877, p. 543; vol. lxxxix., 1879, p. 702; vol. xcii., 1881, p. 866.

* "Ann. de Chim. et de Phys.," vol. xxx. (1873), p. 417.

† "Proc. Inst. Mechanical Engineers," 1893, Part ii., p. 102.

2d. Non-metallic elements present in a metallic mass may change their relation to the metallic atoms; and

3d. The *atoms* in the *molecule* of a solid metal or alloy may be redistributed or rearranged, and this is called *polymerization.*

These molecular changes are almost always accompanied by the evolution or absorption of heat, and can, therefore, be studied by the aid of thermal measurement.

The photographic records have thrown much light on all these cases of molecular change, but for the purpose of minute investigation, another mode of experimenting may be adopted.

Suppose that the spot of light from the galvanometer (Figs. 6 or 7), with which the thermo-couple is connected, does not fall through a slit on to a sensitized plate, but on to a screen placed at some distance from the galvanometer. This screen may be forty feet long, and may be suitably divided into degrees. The room must, of course, be darkened, so that the spot of light may be readily visible. The screen is fixed, and, therefore, the spot of light will traverse it horizontally, and the freezing of a metallic mass would simply be indicated by a more or less prolonged arrest of the spot of light during the solidification of the metal. Suppose, however, that it is not a question of studying the behavior of a freezing metal, but of one which, though it may be strongly heated, is still solid. Take, for instance, the case of a piece of steel of somewhat low carburization which is being slowly cooled. Here the molecular behavior is very complicated. M. Osmond and myself, and, recently, other experimenters, have studied this behavior minutely. There will be at least two arrest points, and probably three, as the pieces of steel cool from bright redness. One of these will occur at a temperature which varies slightly, but is somewhere close to 650° C., and is caused by a change in the relations between the carbon and the iron. An ordinary photographic record obtained on a plate about ten by six inches would simply show a bend in the curve of about the form and amplitude shown in the sketch (Fig. 12). If, however, it is wished to

FIG. 12.

study this particular change more fully, the following plan may be adopted: Assume that, in indicating temperatures up to a white heat, the path of the spot of light along the screen is some forty feet, then it is easy so to arrange the experiment that the spot of light may be received (at the critical part of its path which it is desired to study) on a second but smaller screen, say four feet square, which may be moved upward at a slow but uniform rate of, say, an inch a second. The spot of light from the galvanometer may be divided by the images of cross wires, and, as the point of intersection of these wires is clearly visible on the moving screen, its position at any given moment may be recorded, by hand, with a pencil mark. The result is, that the portion of the cooling curve which represents the "recalescence" of iron, instead of being a small sinuous line, shown in Fig. 12, becomes a loop four feet across, of the form shown in Fig. 13. The

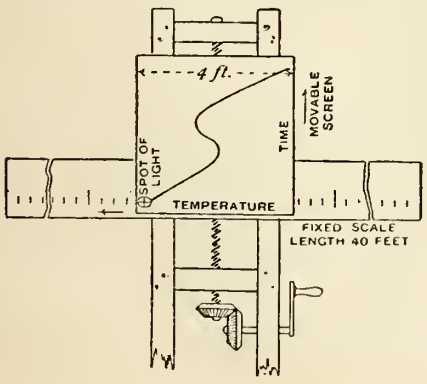



FIG 13.

same degree of magnification may be applied at any period during the cooling of the steel, and it enables the molecular change in the iron which occurs at 855°, that is at a higher temperature than recalescence, to be submitted to a very rigorous investigation. For the purposes of lecture demonstration, it is only necessary to fix a screen of paper on a light frame, and place it like a canvas on an artist's easel, which is provided with a vertical screw for elevating the screen, but it will be evident that for purposes of delicate research some method of uniformly moving the screen could readily be devised.

It is now possible to study the behavior of alloys at high temperatures and to obtain photographic records of the molecular changes by the aid of a simple and trustworthy appliance, which is considered to afford "incontestable" results by so distinguished a pioneer in molecular research as M. Raoult.

## THE PURIFICATION OF WATER BY PRECIPITATION AND SEDIMENTATION.

By Dr. PERCY FRANKLAND, F.R.S.

IN an interesting article on "Recent Improvements in the Manufacture of Aerated Waters," published in *Industries and Iron* on the 27th October last, reference is made to some experiments which I made some years ago* on the remarkable bacterial purification which may be procured by agitating a water with certain substances in a fine state of division, and allowing subsidence to take place. In this manner I found for the first time that bacteria are carried down together with the coarser suspended particles in the water. The substances I used were spongy iron, chalk, animal charcoal, vegetable charcoal, coke and other materials, the coke being especially effective, for after agitating the water for fifteen minutes with one-fiftieth of its weight of this material in a finely divided condition and allowing it to subside for forty-eight hours, the supernatant water was on one occasion absolutely sterile or did not contain a single organism.

It may interest your readers to know that I have quite recently been examining the processes and value of sedimentation, as it takes place on the large scale in waterworks reservoirs, used for the storage of more or less turbid water before submitting it to sand filtration. As these are so far the only experiments which have been made on the large or practical scale, they are of especial interest in bearing out the results which I obtained previously on a small scale in the laboratory.

The object of these reservoirs is, as every one knows, to enable some of the coarser particles in suspension to subside before running the water onto the several filter beds, so that the latter may be taxed with the minimum amount of suspended matter. Although such reservoirs have been constructed without any view to the bacterial purification of the water, this actually takes place to a very remarkable extent, as the following investigations carried out at the works of the London Water Companies show very clearly. Thus, in the first instance, the water in a large cemented reservoir belonging to the Grand Junction Company was examined. The water in this reservoir had been obtained from the Thames at Hampton, and the greater part of it had been stored for six months. Now, I have repeatedly shown in the course of the periodical examinations which I made of the London water supply for the Local Government Board, that this raw, untreated water contains sometimes as many as 92,000 bacteria in one c. c. of water, while the smallest number I have ever found is over 1,000. This reservoir water taken from two different ends of the basin contained, however, only 464 and 368 micro-organisms per c. c., showing that a most remarkable bacterial purification had taken place during the storage of this water.

The value of this process of sedimentation was even more strikingly brought out by the following investigations made at the West Middlesex and New River Companies' works respectively. The Thames water is run successively into two reservoirs at the West Middlesex works, where it remains for some time before being run onto the filter beds. The raw river water running into the reservoir on this occasion contained 1,437 bacteria per c. c.; in the water running out of this reservoir only 318 were found, while after passing through the second reservoir only 177 were present. In the case of the New River Company's water I obtained equally striking results, for, while this water (a mixture of river with spring and deep well water) contained 677 as running into the first reservoir, in that flowing out of this reservoir 560 were present, while after remaining in the second reservoir only 183 micro-organisms were found per c. c.

The hygienic importance of these results is obvious, for, should pathogenic bacteria be present at any time in the raw, untreated water, while some diminution in their numbers will take place already in the course of a river's flow, on collecting the water in these reservoirs there is additional opportunity afforded for their removal by the natural processes of sedimentation which I have shown take place to such a remarkable extent.

It is, therefore, of great importance that in the purification of all water for hygienic purposes the maximum amount of sedimentation should be allowed to take place before the processes of sand filtration or other methods of purification are resorted to.—*Industries.*

* "The Removal of Micro-organisms from Water." *Proc.* Roy. Soc., 1885. *Transactions* Institution Civil Engineers, 1886.

## PLANT CHEMISTRY AND BACTERIOLOGY.

By HENRY WURTZ, Ph.D.

AMONG the many wondrous chemical laboratories in which Dame Nature employs herself without ceasing, those which occupy the cells of plants are in a high degree the most mysterious, inscrutable and astonishing in the results they present to us. Although some few animals secrete or excrete materials of peculiar and exceptional characters and qualities, yet the great majority of their products are very closely similar, in the main, in composition and character, when from animals under normal conditions. Their principal plastic constituents also are usually much the same. But in the vegetable kingdom we find that almost every family has its peculiar and characteristic product or products, found often in no other. Moreover, ordinary plants deal with the simplest compounds of the chemical elements of matter, and are constantly occupied in building up from these more elaborate compounds of the greatest variety and complexity, endowed with potential chemical energies great in amount and variety. These the animal, under normal conditions, is continually occupied in consuming and destroying, and reducing back again to the simplest compounds, which the plant immediately proceeds again to build up into complexity, and endow with energy, for the animal again to use up. The plant is always building beauteous structures, temples and palaces of molecules, merely that the animal may destroy and tumble them into ruins again. The plant process is one of deoxidation or decombustion, while the animal process is always one of oxidation or combustion. The plant, however, does not accomplish this decombustion and accumulation of potential energy in the products thereof, by virtue of any inherent power of its own. Plant life, in some wondrous way, directs, controls, and condenses the energies brought by the heat rays and chemical rays from the sun. With some strange exceptions, of which further on, the plant races are children of the sun.

The present writer wrote as follows on this subject in 1877: "Within the leaf of the plant resides the inscrutable vital influence which is able, with the assistance of the heat of the solar ray, to set up the most mysterious of chemical laboratories, wherein such substances as cellulose and starch (and through these sugars), with still more complex proteid bodies, are elaborated from the simple compounds, carbonic acid and water. Generations may pass away at the present rate of progress of chemical investigation before any real insight will be gained into the chemistry of the plant leaf."*

Nevertheless, the writer was not optimistic enough here. But a few years subsequent to this date, an important insight was actually gained into the way in which these plastic constituents of plants are chemically built up in the leaf cells. A German chemist, Baeyer, discovered that the process consists of two successive steps: *First*, and essentially, in the formation in the leaf, from the moisture and carbon dioxide of the air, of the compound *oxymethylene*, $CH_2O$, also called *formic aldehyde.* This is accomplished by the operation above referred to, simply by the deoxidation (or dissociation by the energy of the solar rays of the carbon and oxygen) of the carbon dioxide, commonly, but inaccurately, called "carbonic acid," of the atmosphere, under the influence of this mysterious vital influence of the plant.

The latter is thus able to transfer the energy of the sun rays to the carbon of the oxymethylene—which comes from the decomposed carbon dioxide—in the form of chemical potential energy, which would be given out again if the oxymethylene were set on fire and burned. The chemical equation of this primary transformation is thus:

$$H_2O+CO_2=CH_2O+O_2;$$

free oxygen passing into the atmosphere, as we know is constantly the case, from the growing leaf. It will be seen that the other product besides the free oxygen, that is, oxymethylene, may be looked upon as virtually a compound of carbon and water, $H_2O$. As it is a gaseous body, which is largely soluble in water, such a solution may be looked upon as in effect a solution of carbon in water. This body, oxymethylene, considered to be formic aldehyde, thus continually being formed in the plant leaf by a natural process, may be produced artificially by passing a mixture of vapor of wood alcohol and air over a red hot helix of copper or platinum wire contained in a glass tube. Such helix may be heated by an electric current.

*Second.*—Like other aldehydes (with many other organic bodies) this formic aldehyde has a fashion of forming *polymeres*, so called. In this case, just as with common or acetic aldehyde, three molecules combine together into one, thus:

$$3(CH_2O)=C_3H_6O_3.$$

This triplicated molecule constituting now a *solid* body instead of a gas. Such solidification of the gaseous compound takes place spontaneously in a concentrated watery solution. Now it happens (or rather results, for nothing can be rightly said to *happen* in chemical transformations, all being subject to fixed laws) that by carrying this polymerization twice as far as above, which the leaf knows how to do, though we cannot yet do it, there results $C_6H_{12}O_6$, which is *glucose*, or fruit sugar. Then by separating from this a molecule of water, $H_2O$, we get $C_6H_{10}O_5$, which is *starch.* By a second doubling up of glucose, and taking out a molecule of water, we get $C_{12}H_{22}O_{11}$, which is *cane sugar.* By taking out another molecule of water, we get $C_{12}H_{20}O_{10}$, which is *cellulose*, the main component of wood and of all plants. It may be observed that in all these cases the resulting polymere may still be regarded as a compound of carbon and water, and the energy that has come from the sun is locked up solely in the carbon atoms, which all come from the carbon dioxide gas of the air. There is no more beautiful development of chemical science than the one we have here been following up.

It is desirable here to emphasize the fact that these are developments mainly of *chemical* science. The botanists, biologists, and microscopists have, until of late, had the great fields of investigation of plant structure, with the transformations and metamorphoses that proceed in plant cells, almost wholly to themselves. The time has fully come, however, when chemistry must step in, and do what man has been endowed with the power to do, namely, to subdue this kingdom of nature. The laboratory and the microscope have indeed already begun to co-operate in earnest, and will jointly achieve discoveries which neither alone could hope to approach. At last summer's meeting of the British Association for the Advancement of Science, several papers were read by chemists of distinction relative to this subject. So many facts of interest and importance demonstrative of the necessity of applying chemical knowledge and laboratory methods to the study of microscopic and microbic vegetation, and their relations to health and disease, to life and death, that a strong impression was produced. The project was started and urged of the immediate "establishment of an institute for research where chemists, biologists and pathologists could mutually assist one another."

The work of the microscope, which has laid the foundation for the great structure of plant chemistry that is now soon to arise, has not been confined merely to the morphology, or study of the forms and minute structure, of such plants as we see around us, without microscopic aid—or rather only with that conferred on us by the Creator—the microscope and telescope combined, which gives us our limited *natural* insight into his illimitable creation. The microscope has further developed to us the existence of generations of plants, whose number baffles human speech to convey and the human mind to conceive, and whose importance to the present welfare and future destiny of the human race is greater than that of any other agency in the scheme of nature. These are the so-called bacteria.

At this last meeting referred to of the British Association, the eminent chemist, Frankland, stated that microscopic manipulations and methods had largely failed in the fundamental matter of recognition and identification, with the needed certainty, of some of the more important forms of bacterian life. This, even when aided by the chemical method, now in universal use, of staining the internal structure of these organisms by soaking them with brilliant dyes. Even in the case of the cholera bacillus or spirillum he said that as much difference had been found "between different specimens as between this spirillum and totally different species."

* "Johnson's Universal Cyclopedia," vol. 4, p. 1117. Under "Chemistry of the Vegetative Process."

He added that "morphological tests have consequently been obliged to give way to chemical and physiological tests." The chemical tests are just now undergoing investigation, some being not yet sufficiently familiar to be fully relied on. We may be sure, however, that an immense number of new tests of this class will be discovered when these subjects of investigation obtain a fair lodgment in the laboratory of the skilled chemist.

Frankland mentioned some examples already known. The cholera bacillus gives a characteristic reaction with the compound called *indol*, with which the typhoid bacillus gives none. The latter, however, coagulates milk, but will not cause the fermentation of glucose. Frankland makes the important though obvious statement that an essential to success in the chemical tests between these pathogenic fungoids is *pure culture*, that is, the culture of each germ by itself, without admixture with the others. The special ptomaines, ferments, or banes to animal vitality, which some of them engender, will doubtless each be found to have its characteristic chemical reactions, when obtained free from others. Experiment has shown also that the culture of the same bacterium, when alone, *in differing media*, will in many cases give identical products. There are classes which contain species *identical* under the microscope, and which can only be distinguished now by determining which of them is the morbific one, through actual experiments on animals. Further knowledge will give us chemical means of detecting which of these produces the deadly ferment. One of this kind is the *anthrax* bacillus, the cause of terrible diseases. Frankland also lays stress upon what he calls "educational culture"—modifications of the nature of the baneful fungoids, by culture in special media, so that they no longer produce the poison, just as we know that other plants may be essentially modified, in color, odor, taste, magnitude, and even in animal digestibility, by special cultivation. One point is especially important, if confirmed further; namely, that while the poisonous bacilli may be made harmless by cultural variations, none of the harmless ones have been yet found to become poisonous. Frankland discussed also the effects of sunlight, peroxide of hydrogen and other bactericidal agents; and the necessity that bacteriologists should acquire a profound knowledge of chemistry and of laboratory methods, while the chemist should, *vice versa*, become also a botanist and a biologist.

At this same meeting a most important paper was read by another distinguished British chemist, Warington, mainly on an important branch of the same subject, possessing special interest, and to which a number of chemists have already given extensive research. This is now beginning to bear fruit. It relates to the property known to be possessed by the most abundant bacteria, of producing directly from decaying nitrogenous materials the dioxide and trioxide of nitrogen, the essential components of the nitrites and nitrates.

All the *ptomaines*, or corpse alkaloids, so far as known, all the *tox-albumens*, as a matter of course, and furthermore, in all probability, the serpent poisons, and blood poisons generally, are nitrogen compounds.

Bacteria, therefore, those at least of the non-morbific kinds (which of course make up the great mass of them, most of the morbific or pathogenic species being comparatively rare) are actual scavengers, and do good work in destroying the corpses of animals, which would otherwise, in time, have encumbered the earth. It is because the germs of these organisms are diffused in almost infinite numbers throughout all soils that corpses buried in the earth so rapidly decay and become inoffensive.

It has recently been discovered also, that although sea water is almost destitute of bacterian germs, yet the *floor* of the ocean is loaded with them. Russel found in mud from the Mediterranean, at 164 feet depth, 245,000 microbes in a cubic centimeter, and in mud from Buzzard's Bay, Mass., 30,000 per cubic centimeter.* Also large numbers in mud from the Gulf Stream, 100 miles from shore and 600 feet depth.

Warington states that to bring the nitrogen of dead animal matter fully up to the point of complete oxidation to nitrogen trioxide, requires the successive agencies of more than one distinct tribe of bacteria. The process of nitrification, so far as yet known, begins with ammonia, though it seems probable that even this will yet be found to be itself a product of a special bacterium. One class of microbes has the property of oxidizing the nitrogen of such ammonia to nitrites, or dioxide compounds, but cannot carry it any further. Another class now takes the task in hand and converts the nitrites into nitrates. Neither of these can perform the function of the other.

The nitrate-making bacterium can make nitrates only from nitrites and not from ammonia directly, and the nitrite-making organism cannot make nitrates, either from nitrites or from ammonia. As the germs of both of these tribes usually occur together in soils and waters, nitrites seldom appear, nitrates being usually found.

Warington announces, moreover, on the authority of another bacteriologist, Winogradsky, a most extraordinary new fact, if fact it be. Namely, that the latter has found a bacterium which engenders nitrates *from the nitrogen of the air*. This, he says, will grow and accumulate nitrogen in a solution of pure sugar, with phosphates and sulphates of lime and magnesia, without any nitrogenous pabulum. The sugar is converted into butyric acid. This would confirm the assertions of Ville and others, who have claimed that plants get nitrogen from the atmosphere in some way.

## ARTIFICIAL INDIGO.

TAKING a retrospect of the general position of the industry which uses as its primary materials benzol and other aromatic hydrocarbons, and builds up from these more complex compounds which find their principal use either in the form of intermediary products or as coloring matters or medicinal preparations, we may consider the results as, on the whole, satisfactory. Manufacturers of coal tar derivatives have been fully employed. The demand has been constantly increasing, and the introduction of new products and the cheapening of the methods used in the production of already established articles have fully compensated for lower prices, and it is certainly most satisfactory to note that this country has participated, if only yet to a modest extent, in the development of this important industry. A large number of patents has again been applied for during the past twelve months, of which the greater part deals with improvements on old or substitutes for existing colors, but there is nothing of an exceptional character to report. I cannot, however, pass from this subject without calling attention to the continued efforts which have been and are being made by chemists to further improve the methods for the production of artificial indigo, which so far possessed only a scientific value, for the reason that this country has a twofold interest in this question. In the first place, we are the principal producers of natural indigo, the annual outturn of which represents a value of about four millions sterling; and, secondly, we are one of the largest, if not the largest, consumers of this coloring matter.

It is now several years since Prof. Bayer made the startling discovery of the synthetical production of one of the most important coloring matters hitherto solely supplied by the agency of nature. The first patent taken out in the name of the professor for the production of artificial indigo was in 1880, then followed a number of patents in rapid succession from 1880 to 1884, having as their primary material either orthocinnamic acid or its homologues or products of substitution. Considerable sums were spent during these years with the object of perfecting the technical methods, and reducing the cost of the necessary intermediate products, but all these efforts were in vain, and artificial indigo remained so far more a chemical curiosity than anything else, except perhaps the very limited use of the orthonitrophenylpropiolic acid.

Little was heard of it by the outside world for some time until attention was again directed to it by Prof. Heuman's beautiful discovery in 1890, which I had an opportunity of illustrating by experiment shortly after, on the occasion of addressing the chemical students at the opening of the session of the Manchester Technical School. Heuman's discovery in the production of artificial indigo proceeded on different lines from those first followed by Bayer, and afterward by others. Heuman heats phenylglycocine with caustic alkalies at about 260° C., when indigo white is the result, which may then readily be oxidized to indigo blue. Here again, unfortunately, notwithstanding the great simplicity of the process, the large destruction of the principal raw material made this process also too expensive for trade purposes.

With all these negative results, so far as the profitableness of the various processes is concerned, chemists have persevered in their efforts to solve the great problem which offers so great a prize, and I will now illustrate a process which might almost be called an extension of Heuman's discovery. In December, 1890, the Farbenfabriken, of Elberfeld, discovered that when phenylglycocine is treated with anhydrous sulphuric acid, an oxidation accompanied by an evolution of sulphurous acid takes place, converting almost instantaneously phenylglycocine into indigo sulpho-acid or indigo carmine. I have here some phenylglycocine (produced by the action of mono-chloracetic acid on aniline) which has been ground up with twenty times its weight of sand in order to moderate the reaction. I now put some of this into a large excess of 70 per cent. anhydrous sulphuric acid. You will notice a yellow coloration, which already indicates the formation of artificial indigo, but in order to make the real color appear it will be necessary to remove the anhydrous acid ($SO_3$) by absorbing it in a large quantity of ordinary sulphuric acid, when you will notice an intense blue coloring matter. I am now pouring this blue acid solution on a block of ice, when the characteristic color of indigo carmine will be more easily perceptible to the eye and we will dye some woolen cloth with this solution after first neutralizing the excess of acid contained therein.

In the year 1882 the Badische Anilin und Soda Fabrik patented a process for manufacturing artificial indigo by treating the solution of orthonitrobenzaldehyde in acetone with alkali. Bayer and Drewsen in the same year further investigated this reaction, and they found that when nitrobenzaldehyde in presence of acetone is treated with very diluted alkali that first a product of condensation is formed, viz., the orthonitrophenyllactoketone, which on further treatment with alkali is instantly converted into indigo. I have here some orthonitrobenzaldehyde, and am now dissolving it in acetone. We will add to it some water, and put to it a few drops of a caustic soda solution; the ketone is first formed, which you will see will be almost immediately converted into artificial indigo on adding a little more of the alkali solution. This reaction, simple as it appears in its execution, was also doomed to failure, on account of its costliness, notwithstanding Eugene Fischer's process, patented in 1888, for a cheaper method of producing orthonitrobenzaldehyde from orthonitrobenzylchloride.

It was, moreover, impracticable to apply the ketone direct to yarn or cloth and then develop the indigo blue direct on the fiber, on account of its comparatively small solubility in water. Some of these difficulties in the way of the practical application of Bayer and Drewsen's discovery have now been overcome by Kalle & Co., of Biebrich, and though their process may not so far be cheap enough to produce indigo direct, the development of indigo in the fiber appears to me likely to find some application in the arts, on account of the superiority of the shades produced, and the greater resistance to light of the lighter shades, and for the reason that new effects can be obtained by it in printing which would be difficult to produce by following the old process, always provided that means be found to reduce the strength of the caustic soda solution which the patentees specify as being necessary for developing the indigo, as a solution of 21° Be., as recommended by the patentees, mercerizes the cotton.

A few months ago Messrs. Kalle & Co. found that when Bayer and Drewsen's ketone is treated with bisulphite of soda, the bisulphite compound of the ketone is formed, viz., the orthonitrophenyllactoketone bisulphite, and this compound has the great advantage over Bayer and Drewsen's of being easily soluble in water, and hence can readily be applied to the fiber; moreover, to obtain the ketone in a pure state by Bayer and Drewsen's method is more costly. I have here the bisulphite ketone; we will dissolve some of it in water, when you will at once observe its conversion into indigo on the addition of a diluted caustic solution. I will now illustrate the application of this compound to the production of indigo shades on the fiber.

This hank of cotton yarn we will pass several times through a solution of the ketone; squeeze it and then take it through a caustic soda solution, when it will be dyed a deep indigo blue. I have also here some cloth that has been prepared by printing upon it a solution of the ketone thickened with dextrin. We will now pass it through caustic soda, when the cloth which was previously practically colorless will be colored indigo blue in all parts which had been impregnated with the ketone.—*Ivan Levinstein, in Journal Society Chemical Industry.*

* Equal to about half a million per cubic inch.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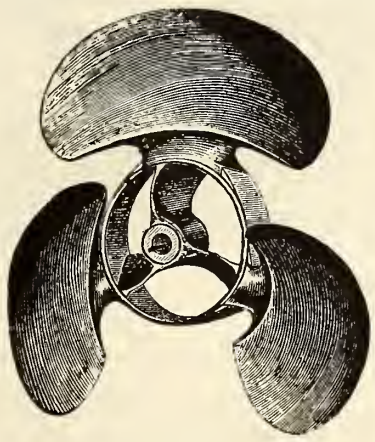
## A GREAT STEAMER.

THE Gothic is the name of a large twin-screw steamer just from the yard of Messrs. Harland & Wolff, Belfast, and is the latest addition to the well-known fleet of the White Star line. Her dimensions are: Length, 490 ft. between perpendiculars; breadth, 53 ft.; depth of hold, 33 ft.; and gross tonnage, 7,720. She has been specially designed for the New Zealand service, and will be dispatched from London by the Shaw, Savill & Albion Company on her first voyage, on December 28, calling at Plymouth, Teneriffe, Cape Town, and Hobart on her outward passage, and Rio de Janeiro and Teneriffe on her homeward. The distance traversed on the round voyage exceeds 26,000 miles, and in thus for the first time introducing a double set of full-powered engines propelling twin screws into the New Zealand trade, the owners of the White Star line and the Shaw, Savill & Albion Company believe they are acquiring an additional element of safety. Unrivaled accommodation of the highest class, similar in character to that which has been so much appreciated in the Teutonic and Majestic, is provided for 104 saloon passengers amidships, the dining saloon and many of the superior state rooms being above the main deck, so that the ventilation is as complete as possible, and in the control of passengers themselves. In the quarter-deck aft there is accommodation of a unique character for 114 steerage passengers.

In addition to ordinary coal and cargo space, the Gothic has an insulated capacity in the refrigerated chambers capable of stowing some 75,000 carcasses of sheep, the temperature of which is maintained and regulated by two of Hall's most powerful carbonic anhydride machines, which have proved so successful in the large freezing establishments in New Zealand. Special provision has also been made for the conveyance of dairy produce, the export of which is a new development in the industry and enterprise of the New Zealanders, and one which has found great favor with consumers at home. The Gothic is the largest steamer as well as the largest carrier in the Australasian trade; and as a new departure, her appearance is a matter of much interest to colonial shippers. She is the largest ship, with the exception of the Great Eastern, which has ever entered the port of London.

## THE BELDUKE PROPELLER.

THE illustration shows a pattern of screw propeller which has been the result of an investigation into the subject of screw propulsion, undertaken by Mr. Joseph Belduke, of San Francisco, and which has been tested in practice with encouraging results. The design will be evident from the view we give, and we are promised further particulars at a later date. It is well known that the French

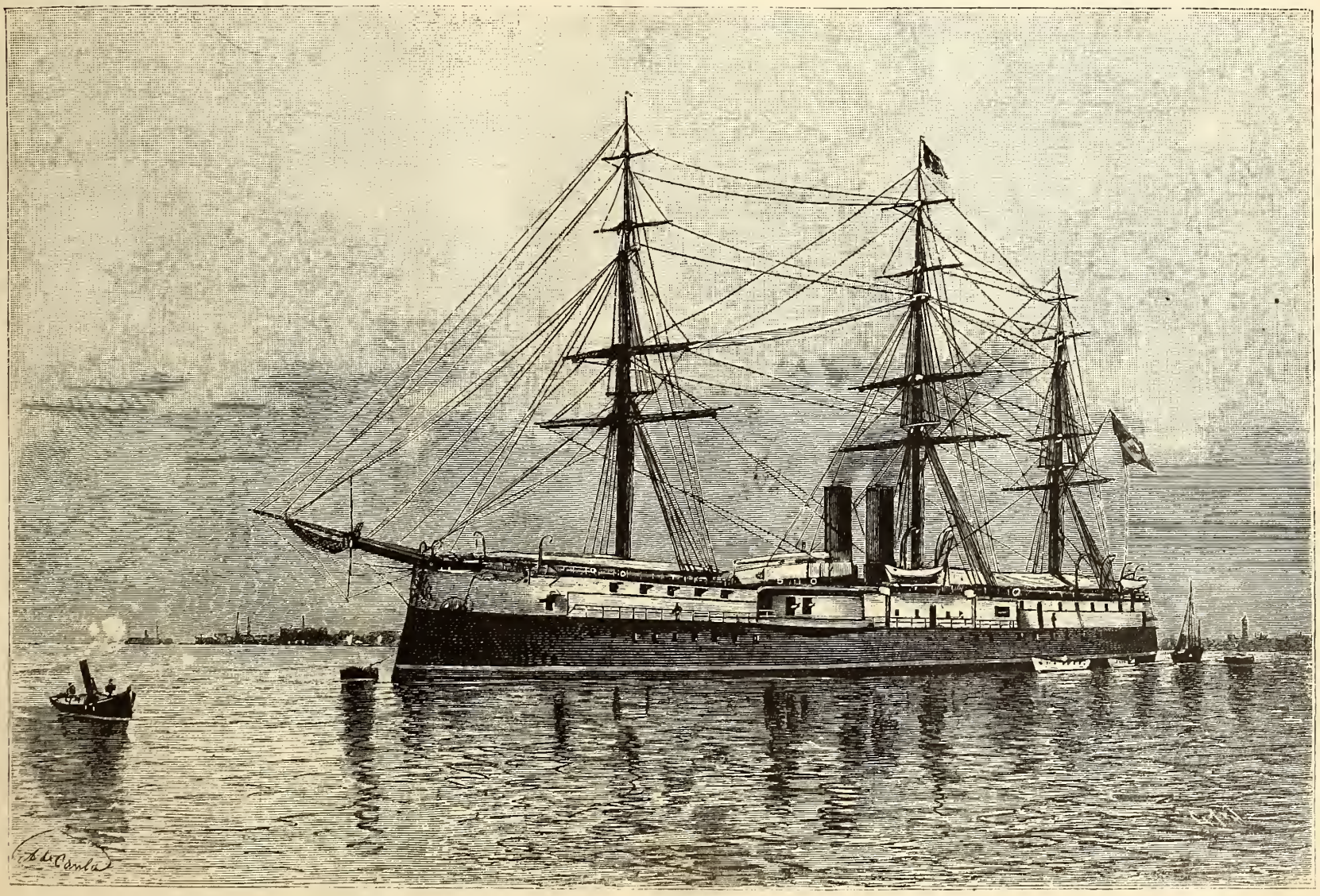


government have in their archives some three thousand different patterns of screw propellers, and it would be interesting to hear whether one similar to the Belduke is contained in the collection. The present form of the propeller is based upon the analogy of the screw, and originated in the cross-section of a bolt cut at a right angle. A general reduction of the blade at the point has taken place, and at the same time an increase in the boss, with the object of passing the water aft as uniformly as possible. Modern practice has shown that one-third of the tip-to-tip of blade diameter may be filled up without any perceptible difference in speed, thereby conceding the ineffectiveness of a large portion of the diameter. The action of the blades at starting is to cause one component of the force to tend to pull down the stern of the vessel, and this is readily noticed in launches. In the case of the new design it is claimed that a saving of power of from thirty to forty per cent. is effected, and the slip is reduced to thirteen per cent., while the vibration is materially reduced. Trials with a hundred-foot yacht on the Hudson River; with the screw yacht Restless and a tug boat tested at Havre have gone to substantiate some of these claims, although in the last case the propeller was 8 ft. 6 in. in diameter, and in the others particulars are not given, so that it is impossible to say whether the design or mere size is the explanation of the satisfactory results so far obtained. A propeller of this design was also tried on second class torpedo boat No. 66 at Portsmouth, which, with her standard type of propeller, gave fourteen knots, while with one of the new pattern nineteen knots were obtained, with a diminution of one hundred revolutions, six hundred and twelve and five hundred odd respectively. A similar pattern of propeller is due to Ericsson, and good results were obtained with it in the American navy, but the type does not seem to have survived.—*Industries.*

## THE SUBMARINE BOAT GYMNOTE.

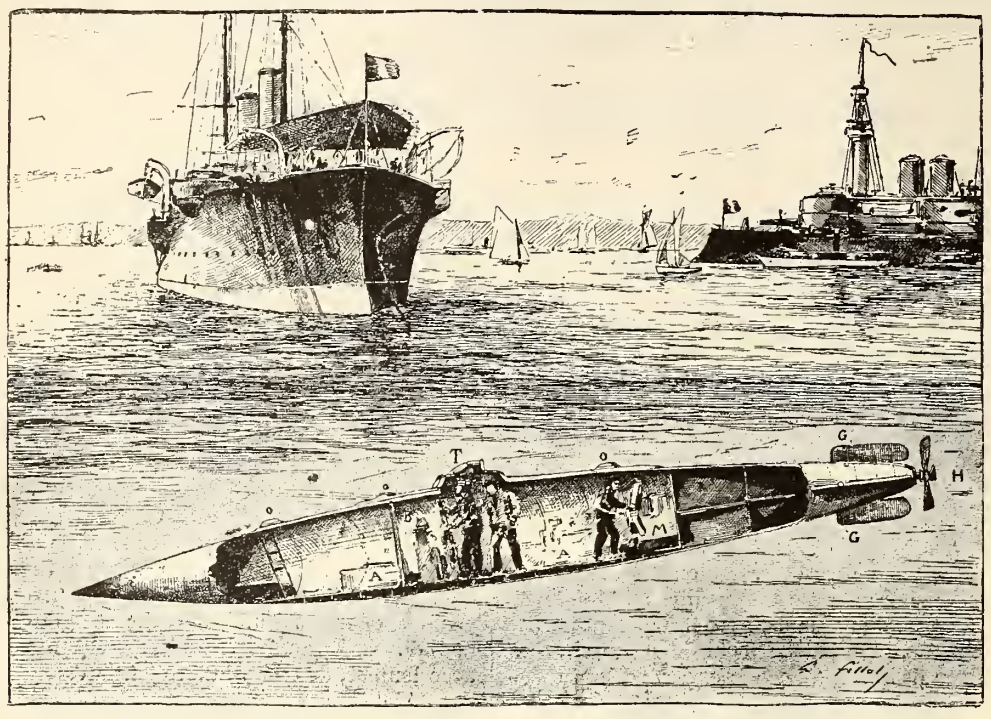
THE submarine boat is destined to render immense services to science by allowing of the exploration of the unknown regions of the bottom of the sea. It almost realizes the ingenious idea of Jules Verne, popularized by his famous romance, "Twenty Thousand Leagues under the Sea." It may also be considered a formidable engine of war. From this standpoint its *role* has not as yet been well defined, but it can already be admitted that a flotilla of submarine boats would lend valuable aid to the defense of our coasts. It would render a blockade impossible and a bombardment dangerous, and would notably modify the rules of naval strategy.

It is in France that has been found the first practical solution of submarine navigation. The tentatives made in recent years in England and the United States have been marked by signal failures. We owe this



THE INSURGENT BRAZILIAN WAR SHIP AQUIDABAN.

admirable invention to a French engineer, Mr. Zede, ex-director of our naval constructions, who established the plans of a submarine boat with so much science that all his anticipations were realized at the first stroke. He conceived the ingenious idea of the application of the electric motor to submarine locomotion. This motor undergoes no loss of weight during its operation, requires no oxygen, disengages no gas, and is consequently wonderfully well adapted to navigation under water.



THE SUBMARINE BOAT GYMNOTE.

Gymnote is the name that Mr. Zede has given to his submarine boat. Its form is that of a very tapering spindle, since it is 18 meters in length by 1·8 meter in diameter. The boat has a displacement of 30 tons. Its speed reaches from about 9 to 10 knots. Its immersion is regulated, not by the introduction of water in variable quantity into its reservoirs, but by the simple action of horizontal rudders analogous to those of the Whitehead torpedo. The maneuvers are executed electrically. It is thus that it controls its pumps, provides for its lighting, etc.

Captain Krebbs and Engineer Romazzotti were valuable colaborers of Mr. Zede, the first named occupying himself with the electric part. The motor adopted, which is of 55 horse power, is extremely light. It actuates the screw directly without gearing, and communicates to it a velocity of 200 revolutions. Its weight is about 2,000 kilogrammes. The current that supplies the motor is furnished by Commelin-Desmazures accumulators. Mr. Romazzotti had in charge the construction of the boat.

Mr. Zede's experiments, which caused such a sensation in France and other countries, took place at Toulon, in the presence of Vice-Admiral Charles Duperre.

When in service, the Gymnote has a crew of but three men—a captain, an engineer and a sailor. It had five persons on board on the day of the trial—Mr. Zede, Captain Krebbs, Naval Engineer Romazzotti, Naval Lieutenant Baudry de Lacantinerci, the future commander of the vessel, and Foreman Picon, who superintended the construction of the boat in the Mourillon slip.

Upon the submersion of the Gymnote, its tightness was found to be perfect, and the plunging and ascending were executed with admirable facility.

The rudder and motor operated perfectly, and the boat preserved its speed well close to the surface of the water. After taking its accumulators aboard, the boat with all its *materiel* was found to be in a perfect state of submersion. Ready to continue its experiments, it was steered over the roadstead outside of the lines of the moorings. The submarine boat was then seen to dive several times for a few minutes; come to the surface again; then descend again to a depth of four meters and reappear at the surface, and all this with extraordinary facility. Then, suddenly descending in the water to a depth of seven meters, it reappeared after traversing a distance of about five hundred meters, and having preserved in the interval a speed of ten knots.

During its stay under water respiration was not impeded. During the submersion the boat took on a rolling motion; its engine worked fore and aft with sureness, and the rudders operated to perfection. Those present at these experiments could not conceal their real feelings, not being able to believe in so perfect a result.

The Gymnote was then recognized as a formidable engine of war, and, as soon as it was provided with its military apparatus, it took a rank among the movable vessels of defense of the port of Toulon.

The inventors are now pursuing their experiments with the object in view of improving the boat, which, in fact, is but an experimental one, designed to demonstrate the possibility of submarine navigation.—*La Science Moderne.*

## AMMONIA MOTORS.

The use of ammoniacal gas for the production of motive power has already been the object of numerous tentatives, which, as well known, have not, up to the present, given very practical results or sufficiently economical rendering to compensate for the increase of the cost of installation.

It is permissible to hope that the new researches made in this direction in America, in utilizing ammonia no longer in aqueous solution, but in an anhydrous state, will have better results.

Even if success should not respond completely to the hopes of the promoters, these new tentatives would, nevertheless, preserve a very interesting character, and so much the more so in that at present the companies carrying passengers in cities appear to be favorably disposed to substitute mechanical for animal traction.

It is well known that, at a temperature of —39°, ammoniacal gas liquefies at the pressure of the atmosphere, and that the same phenomenon occurs at + 21° under a pressure of 10 to 13 kilogrammes per square centimeter. In this last state, the expansion of the ammoniacal gas produces a great depression of the temperature that it is important to avoid. To this effect there is utilized the powerful affinity of ammonia for water, which absorbs as many as seven hundred times its volume of it. After expanding in the cylinder of a motive piston, the exhaust ammoniacal gas is dissolved in the water, to which it gives up all its latent heat of vaporization, which serves to heat the liquid ammonia reservoir and the cylinder of the motor. It can afterward be recovered from this solution by heat, so that the ammonia accomplishes a closed cycle, as in the well known ice machine of Mr. Carré, in which the phenomena are almost identical.

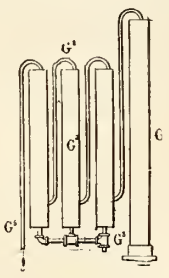
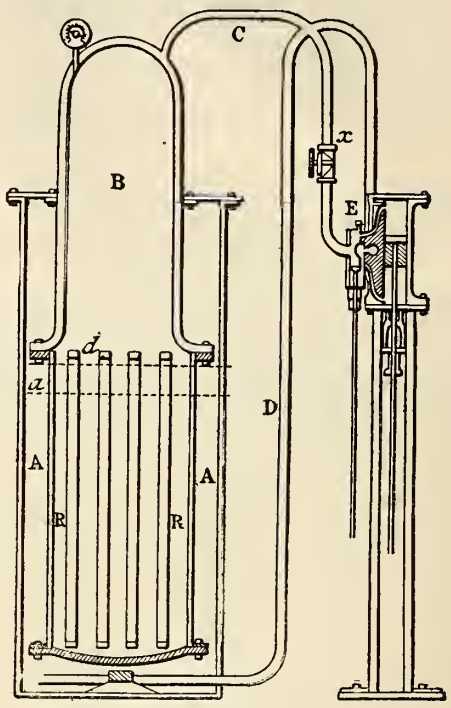


FIG. 2.—DEHYDRATOR.

Among the old ammonia engines, the operation of which is based upon this principle, that of Dr. Emile Lamm is the most remarkable. In 1870 he pointed out, as the characteristic of his system, the transmission of the latent heat of the gas to the water of absorption, and then of this latter to the liquefied gas, in order to keep up its evaporation.

The annexed figure gives a diagram of this motor. R R is a receptacle containing anhydrous liquid ammonia up to the level, *d*, and surrounded by the reservoir, A A, containing, up to the line, *a*, a weak ammoniacal solution that fills the tight tubes of the receptacle, R. Ammoniacal gas at a high pressure fills the dome, B, of the latter and is capable of being sent, through the conduit, C, and the cock, *x*, into the distributing box, E, of the motor. It escapes therefrom through the pipe, D, which debouches at the bottom of the reservoir, A, where the dissolving of it is effected. At the beginning of the work the motor operates at a pressure of 10·5 kilogrammes per square centimeter, at a temperature of 32° C., which the ammonia reservoir must preserve during the whole time of the operation.



LAMM'S AMMONIA MOTOR.

One of the principal difficulties experienced in the treatment of the aqueous ammoniacal solution, enriched by the exhaust gas, consists in its conversion into anhydrous liquid ammonia. If the latter is not entirely deprived of water, its efficiency for the production of motive power will be diminished. So one has been led to the establishment of complete installations for the production of anhydrous ammonia, but which, in an exploitation of tramways, is of a nature to sensibly increase the expenses of the first establishment.

We are going, moreover, to allow our readers to judge of this in describing in a very detailed manner the apparatus devised by Mr. MacMahon for the recuperation of the ammonia employed for the propulsion of cars in a motor of his system, which some time ago made considerable of a stir in the United States at the beginning of the Chicago Exposition.

These apparatus, represented in Figs. 1 to 3, are permanently installed in the vicinity of the tramway line served by them.

The liquid ammonia, or concentrated aqueous solution of ammoniacal gas, is treated in the extractor, A, which it fills up to $A^2$, that is to say, much above the tubes, $A^1$, where enters through the bottom the steam coming from the boiler, $E^2$, situated at the right extremity of the installation.

The ammoniacal gas separates from the solution

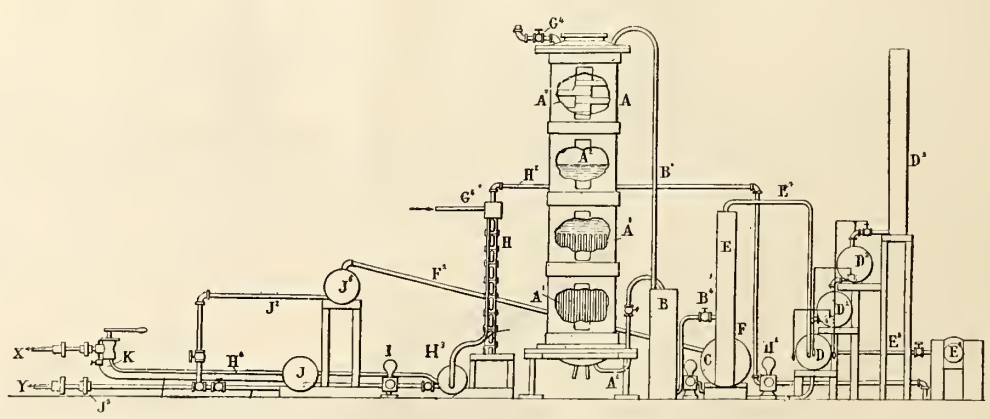


FIG. 1.—INSTALLATION FOR THE DEHYDRATION AND RECOVERY OF AMMONIA.

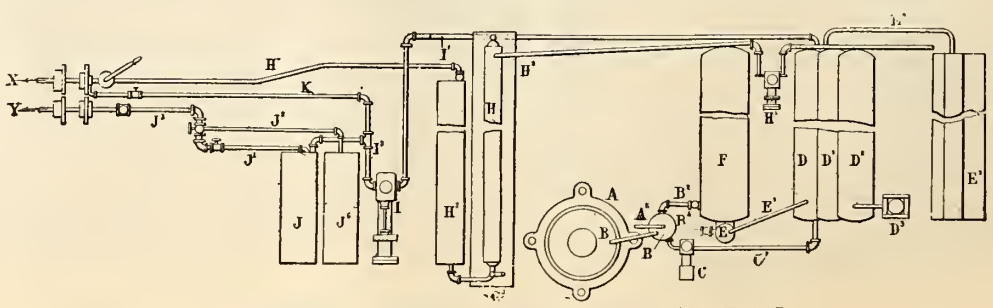


FIG. 3.—PLAN VIEW OF FIXED INSTALLATION.

thus heated and enters the dehydrator, G (Fig. 2), which surmounts the extractor, A, and which is figured isolatedly at its left, in order to facilitate the grouping of the figures of the plate. Here the ammoniacal gas traverses in succession the cylinder, $G^1$, and the vertical driers, $G^2$, the water from which returns through the conduit, $G^3$, and the cock, $G^4$, to the extractor, A, where it falls in a cascade upon the diaphragm, $A^3$, to mix anew with the solution under treatment.

The gas thus dehydrated enters the condenser, H

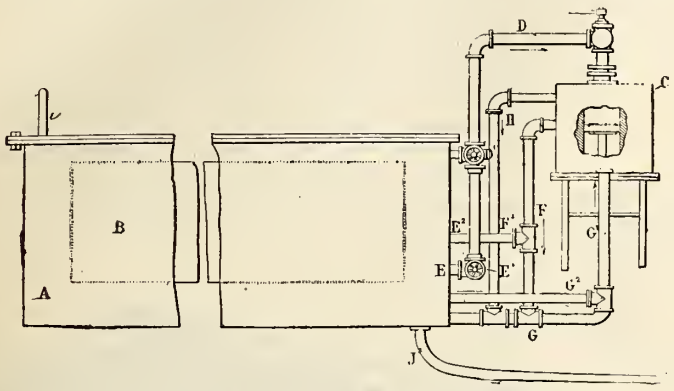



FIG. 4.—MOTOR WITH ITS WEAK SOLUTION AND ANHYDROUS AMMONIA CISTERN.

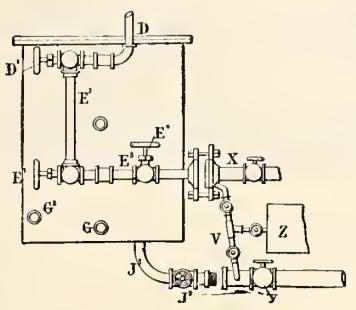



FIG. 5.—CHARGING OF THE CYLINDER AND ITS CISTERN.

(Fig. 1), through the pipe, $G_5$, placed at the point of origin of a worm, upon which a box with a perforated bottom allows to fall a shower of cold water continuously led by the pipe. $H_2$, from the pump, $H_1$. The anhydrous ammonia thus obtained flows into the receptacle, $H_3$, and thence reaches the conduit, $H_4$, whose valve cock supplies the conduit, X, connected with the motor.

The ammoniacal solution, from which the gas is separated, is sent in a continuous manner into the extractor, A, by means of the feed pump, C, which lifts it through the pipe, $C^1$, into the reservoir, D, and forces it through the temperature exchanger, B, whose vertical conduit, $B^1$, debouches at the top of the extractor, A, where the solution falls in a cascade upon the diaphragms, $A^3$.

The impoverished solution is continuously removed, through the pipe with cock, $A^5$, from the bottom of the extractor, and led through the exchanger in a

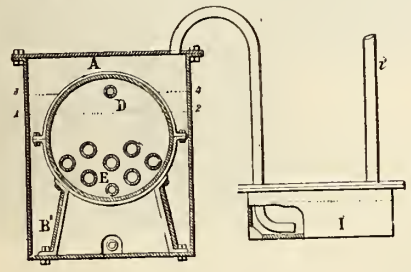



FIG. 6.—PURIFIER OF EXHAUST AIR.

direction opposite that of the richer solution, which rises at B'. It is afterward sent either directly through $B^2$ into the reservoir, F, or by preference through the conduit, $B^4$, into the column, E, which, not being under pressure, allows every facility to the ammoniacal gas still dissolved to disengage itself. This gas escapes through $E^1$ into the solution of the reservoir, which thus becomes concentrated to the detriment of the solution reaching E, and which flows into the horizontal reservoir, F, and then, through the conduit, $F_1$, into the cistern, $J^6$, containing a weak solution. This latter is afterward utilized in the apparatus of the automobile car, to which it may be sent by the branches, $J^2$ and $J^3$, of the conduit, T. It serves to reabsorb the exhaust gas of the motor. Once concentrated anew, it is replaced at the same time that the supply of anhydrous ammonia in the locomotive is renewed.

In order to replace this solution, the return piping,

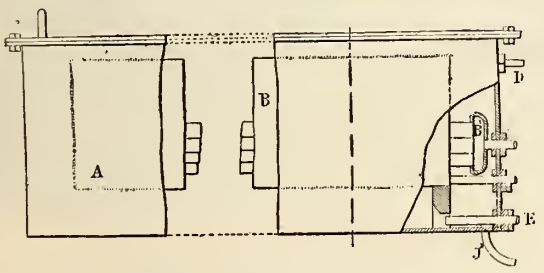



FIG. 7.—CISTERNS FOR EXHAUSTED SOLUTION OF ANHYDROUS AMMONIA.

Y $J^2$ and $J_1$, is employed, which leads it into the cistern, J, where it is regularly sucked up by $I_2$ into the pump, I, flowing back at $I_1$ into the lowermost of the superposed reservoirs, D, $D_1$, $D^2$ and $D^3$, established to the right of the installation. These reservoirs are filled with water, but the column, $D^3$, is only partially so. They are connected in couples by pipes provided with cocks, actuated by means of levers, in such a way that the liquid of the column can pass in succession from one to the other of these reservoirs.

The concentrated solution coming from the motor mixes with the water of the reservoir, D. The gas in excess passes at $D_1$, then at $D_2$, and finally into the column, $D_3$, where it becomes absorbed, so that the air that the gas may have carried along may be allowed to escape through the top of the column. As for the lubricating oils, they are got rid of by sending the upper layers of water of the column, $D^3$, into the boiler, $E^7$, which furnishes steam to the extractor, A. The ammonia, still dissolved in this water, separates from the bottoms of which extend tubes that in front debouch through ajutages in the chamber, $B_1$ (Fig. 10).

Alongside of these apparatus we find the engine (Fig. 4) into the cylinder, C, of which the ammoniacal gas is admitted through the valve of the conduit, D, as well as through the pipe, E, starting from the receptacle, B, containing anhydrous liquid ammonia. Between the cocks. $E_1$ and $D_1$, of these conduits is interposed a glass tube, $E^2$, that shows the level.

The exhaust from the motive cylinder takes place through the pipe, F, which carries a branch, $F_1$, that debouches in the chamber, $B_1$, of the receptacle, A, and afterward communicates through a prolongation with the pipe, G, ending at the bottom of the jacket of this cylinder; finally, at the top of the jacket is the waste-pipe, H, which also is united at G.

The escapement of the air for the purging of the ammoniacal gas is assured in an ingenious manner. Upon the back of the receptacle, A, there is a pipe, *i*, that debouches above the level of the water contained in the box, I (Fig. 6). The ammoniacal gas coming from the cistern, A, dissolves in this water, whence it may be recovered, while the air carried along escapes in

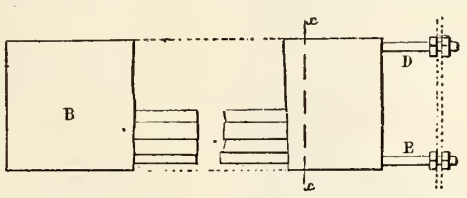



FIG. 8.—ANHYDROUS AMMONIA CISTERN.

bubbling through the conduit, $i_1$. In this way are prevented not only losses of ammonia and its disagreeable odor, but also a counterpressure back of the motive piston.

By reference to Fig. 5 it will be seen that with the bottom of the level indicator is connected, perpendicularly to the conduit, E, the pipe, $E^3$, provided with a check valve, $E^4$, and flanges for its junction with the piping, X, which is traversed by the anhydrous ammonia obtained in the fixed installation.

This liquid enters the cylinder, B, through the cock, $E^4$, and under pressure. Previously a partial vacuum has been formed in the conduit, X, by means of a small pipe, V, leading to a box, Z, connected with the vacuum pump, I, through the pipe, K (Fig. 1).

The receptacle, A, carries also a charging conduit, $J^3$, with a cock, $J^2$, for the introduction of a weak ammoniacal solution by means of the conduit, Y, starting

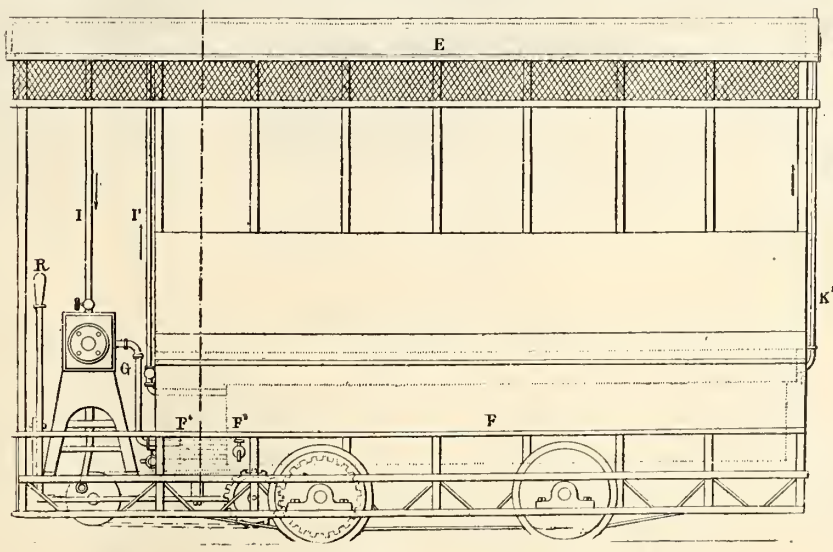



FIG. 11.—CAR ACTUATED BY AN AMMONIA MOTOR.

from the reservoir, $J^6$, of the plant, and in which also a vacuum is made by the pipe, V, before the charging.

Inversely, if, for any reason whatever, it were of interest to discharge the cylinder, B, it would be effected through X, after closing the conduit, $H^4$, this permitting the pump, I, to suck up the liquid at K and force it to D (Fig. 1). So, too, after the exhaust of the motor has concentrated the solution of the receiver, it is discharged through $J^3$, Y $J_1$, under the suction effected at $I^2$ by the same pump, $I^2$.

The charging of the cylinder, B, is done up to the level, 1—2, a little beneath the port, D (Fig. 6), and the weak solution, designed to absorb the ammoniacal gas, is introduced a little higher up at 3—4. In measure as the work proceeds, the level at B descends, while it rises at A.

As may be seen (Fig. 6), thin partitions, $B^2$, unite

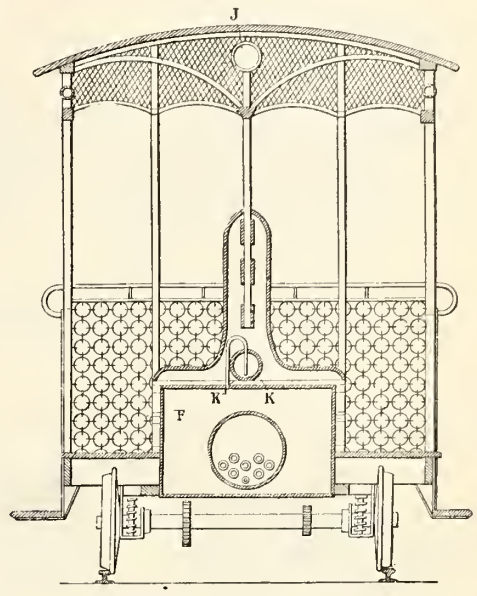



FIG. 12.—CROSS SECTION OF THE CAR.

the supports of the cylinder, B, in pairs longitudinally, and extend throughout its entire length. Their object is to cause a circulation of the solution in the receiver, A. In fact, the lower and central liquid stratum which receives the exhaust of the gas becomes heated in absorbing it, and circulates along the partitions until it reaches their opposite extremity. In this travel it becomes progressively cooled, and then circulates to the exterior of the partitions from back to front. This continuous motion of the solution, beneath the cylinder, B, as well as in its tubes, facilitates the absorption of the gas and the exchange of temperatures.

Let us now examine the operation of the motor,

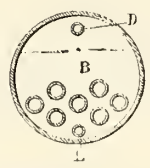



FIG. 9.—SECTION THROUGH *x x*.

which, to tell the truth, is studied in a very summary manner from the standpoint of its mechanism. The ammoniacal gas is admitted through the cock, $D_1$, and the stop valve. Once the stroke of the piston accomplished, the gas escapes at F. One portion goes through $F_1$ into the chamber, $B_1$, and penetrates the ajutages of the tubes of B, where it causes a circulation of the weak solution. The other part of the exhaust debouches in the lower conduit, G, and distributes itself therein to the right and left. At $G_1$ this gas betakes itself to the jacket of the motive cylinder and causes the circulation therein of the solution, which, through the waste-pipe, D, reaches the receiver, A. Through its disengagement to the left of the conduit, G, where there is a sort of injector, the rest of the exhaust aids, besides, the circulation in the cylinder jacket, in producing a sort of suction in the conduit, H. As the gas thus injected is immediately absorbed

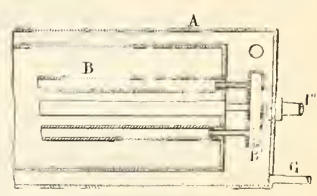



FIG. 10.—LONGITUDINAL SECTION OF THE CISTERNS.

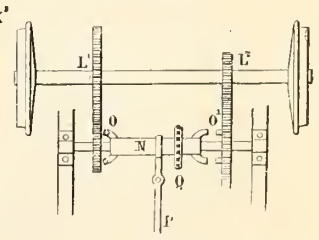



FIG. 13.—MECHANISM OF PROPULSION.

by the solution that traverses the tube, $G^2$, supplying the jacket, C, and to which it imparts its latent heat, the jacket not only does not become cool during the work, but even becomes heated, despite the lowering of the temperature produced in the motive cylinder through the expansion of the gas. The same is the case in the receiver, A, so that the evaporation in the

cylinder, B, is kept up in a most efficacious and economical manner.

The apparatus that we have just described are arranged upon the passenger car, represented in Figs. 11 and 12. Beneath the seats is established the weak solution cistern, F, which receives the exhaust of the motor through the pipe, G. The interior anhydrous ammonia cylinder communicates through the conduit, $I^1$, with a gas reservoir, J, placed under the roof, E, of the vehicle in order to play the role of a drier and serving the motor in its turn by means of the pipe, I. A purger, K, mounted upon the cistern, F, with a siphon, $K^1$, has its exhaust pipe at $K^2$. Finally, $F^3$ designates the charging cock of the reservoir, F, and $F^4$ that of the interior cylinder.

The motor is arranged at one of the extremities of the car. Its mechanism is shown in the figure only by way of example. It actuates an axle (Fig. 12) through an intermediate shaft, N, and either of the two-speed gearings, $L^1$, $L^2$. Upon this shaft there is a coupling box maneuvered through the rod, P, connected with the lever, R, placed near the motor. According to the position of this box, one or the other of the gearings, $OO^1$, participates in the motion of the shaft, N, which is actuated by the motor through a chain pulley, Q. This coupling box may likewise be made to occupy its mean position, so as to stop the car without arresting the operation of the motor.

A MacMahon motor, constructed by way of experiment, was exhibited at the Chicago Exposition. The vapor produced by the anhydrous ammonia kept a temperature of 25° or 26° through the absorption of its latent heat of vaporization in the water of circulation, and was distributed alternately over the two surfaces of the piston of the motor. At the start, the pressure fell to 9 kilogrammes per square centimeter, but under way it soon rose to 11 and even 12 kilogrammes; thus showing the increase of temperature due to the condensation of the exhaust of the ammoniacal gas.

The charging of a new supply of anhydrous liquid ammonia sufficient for a run of 29 kilometers, and the extraction of the concentrated bath in which the ammonia is recovered, were, it appears, effected in two minutes.

If, as is asserted, the tightness of the apparatus permits of preserving the charge intact for any length of time, the sole running expense of this system is thus reduced to the coal burned for the recovery of the liquid ammonia.

The experiments above mentioned were effected in very cold weather, that is to say, under unfavorable conditions. One kilogramme of coal was burned to obtain 8·35 liters of anhydrous liquid ammonia, and, for propelling a car weighing five tons at a speed of 25 kilometers an hour, 14·1 liters per kilometer were consumed. The corresponding consumption of coal was 1·69 kilogrammes, and, at the cost of 35·33 francs per 1,000 kilogrammes of coal delivered at the generating station, the kilometric expense, it appears, did not amount experimentally to 0·06 franc. It would have been interesting had a general idea been given of the expenses necessitated by the installation and the service of the plant. It ought not to be forgotten, either, that apparatus to contain anhydrous ammonia must be of exceptional strength, since, in summer, for example, very high pressures may develop in them that might not be without danger.—*Revue Industrielle.*

[FROM POWER.]

## THE POWER STATION AT NIAGARA.

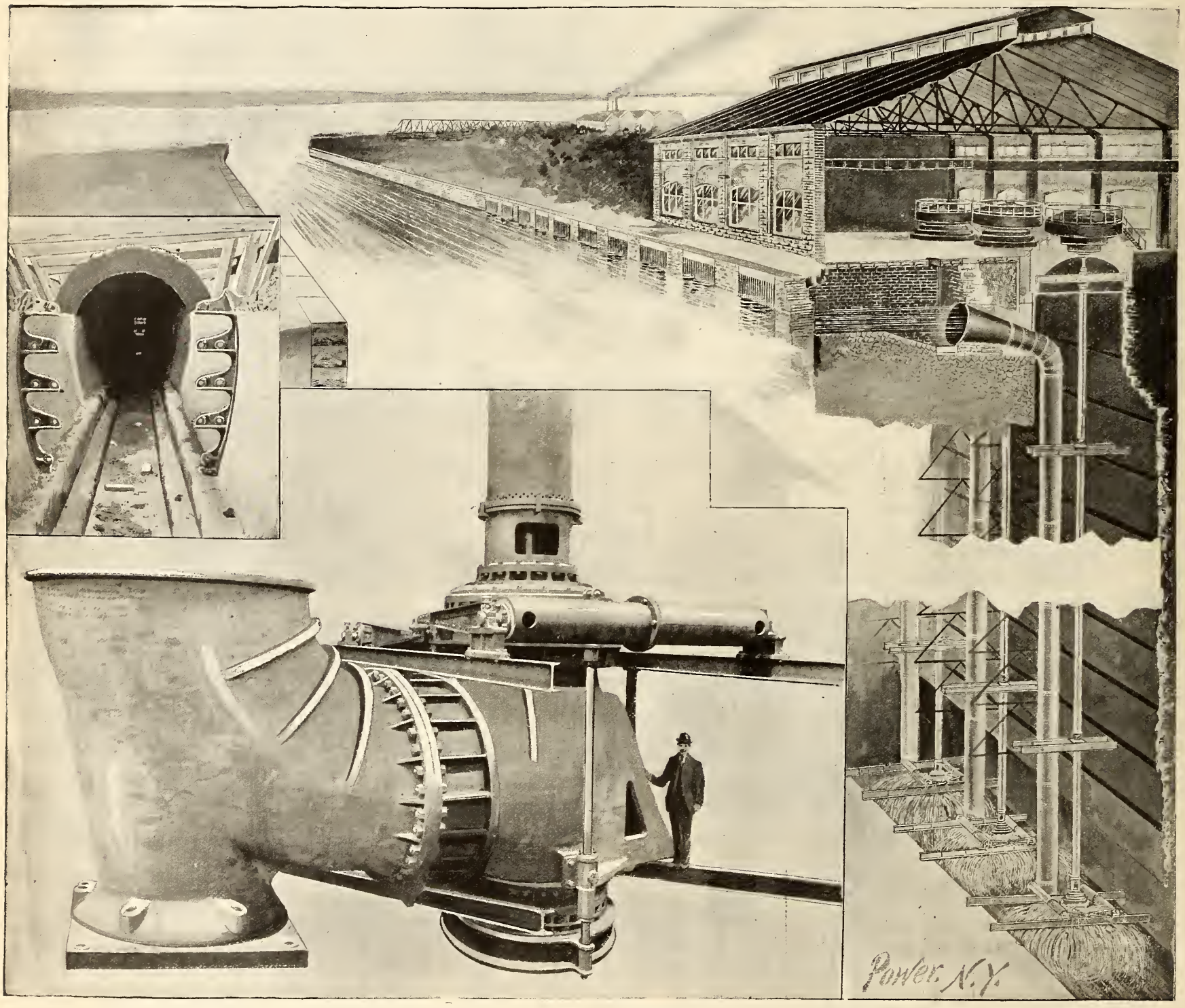
BY the time this paper reaches its readers, if the expectations of the builders are realized, the great tunnel at Niagara will have commenced to discharge water, which, instead of falling purposeless over the cliff, has been diverted and applied to useful work. The first mill to make use of the power rendered available by the tunnel will be that of the Niagara Falls Paper Company, who have arranged to use 3,000 horse power at the outset. Interest centers especially, however, in the 50,000 horse power electric station which the Niagara Falls Power Company are erecting on the main canal, and which it is expected will be in operation at an early date.

The units in this station are 5,000 horse power Westinghouse alternating dynamos, each with its revolving field directly connected to the vertical shaft of a 5,000 horse power twin turbine, built by the I. P. Morris Company, of Philadelphia, from designs furnished by the Swiss firm of Faesch & Piccard. The size and appearance of these powerful wheels is shown in the engraving on this page. They are of the Fourneyron or Boyden type, designed to develop 5,000 horse power under about 140 feet head and at 250 revolutions per minute. The turbines are cast of bronze of the same quality as that used for the propellers of steamships. The main canal, on the west side of which the power station is located, is 188 feet wide, and 17 feet deep at the river, narrowing to 116 feet in width, but preserving the same depth throughout its length of 1,260 feet. The water will be carried in the canal to a depth of about 12 feet. The sides of the canal are built of solid masonry, seven feet thick at the bottom, tapering to three feet thick at the top, on which is a coping two feet and a half wide. From this canal the water is taken through a separate inlet for each wheel, and carried through a penstock seven feet in diameter into the center of the turbine. It is then discharged through directing passages, upon the movable blades of the wheel, of which there are 32, the directing passages being formed by 36 deflecting plates.

The shaft is vertical, bringing the wheels proper into a horizontal position, one at the top and one at the bottom of each case; and gates controlled by the governor are made to uncover more or less of the discharge opening, according as more or less power is required. It is expected that the governing mechanism will control the speed under ordinary variations of load within a variation of less than one-half of one per cent., and when one-quarter of the entire load is thrown off at once, the variation of speed is not supposed to be more than three per cent.

To maintain the efficiency of the wheel on less than full gate opening, the discharge passages and blades are divided vertically into three compartments, so that when the gate is only one-third open, for instance, the wheel is in the same condition as to direction and velocity of water discharged upon the blades as though the gate were completely open.

One serious engineering problem to be met in this installation was that of supporting the weight of the long vertical shaft and the attached portions of the dynamo, amounting to about 152,000 pounds, and the enormous downward pressure of the column of water in the penstock. This is solved in this design by closing the bottom of the casing, so that the water cannot act downward upon any of the parts attached to the shaft, while in the upper end of the casing are apertures through which the water can act upon the under side of the disk carrying the movable blades of the upper turbine and relieve the bearings of the weight of the shaft. In this way the weight of the water column is sustained by the stationary portions, which can be braced and supported for the purpose, and the pressure due to the head made to act upon for supporting the weight of the revolving shaft, which is thus




FIFTEEN THOUSAND HORSE POWER ELECTRIC GENERATING PLANT AT NIAGARA FALLS.

nearly in the condition of a shaft spinning upon the water. The area involved is so proportioned that when the wheels are lightly loaded the upward pressure will be some 2,000 pounds in excess of the weight of the shaft, and when the wheels are running at full gate about the same amount less than the weight of the shaft, on account of the lesser pressure in the casing. This variation in pressure and direction is taken care of by a thrust bearing shown in section in the detail drawings.

The shaft consists of a steel shell about a foot in diameter, with smaller solid portions in the journals, which require to be of less frequency on account of the stiffness due to the large diameter of the hollow shaft. The latter is of rolled steel tubing, without any visible vertical seam. No flywheel is required, sufficient momentum and inertia being furnished by the heavy fields of the dynamo which are carried upon the shaft.

The dynamos are constructed upon the two-phase alternating current system, with stationary armature and revolving fields, and are designed to generate a potential of 2,000 to 2,400 volts, which will be increased or diminished by step-up or step-down transformers for transmission or local use. Motor generators will be run for the production of continuous current when required, so that the station will be able to furnish continuous or alternating current of any potential. Two-phase Tesla motors will be used. The station is designed eventually to comprise ten of the units described, and the wheel pit and building will be extended toward the river and new wheels put in as required. Meantime power from the station itself will be available for carrying on the work, extending the wheel pit and the main tunnel, and the many mechanical operations connected with grading and inaugurating the industrial city which will grow up about this source of cheap and continuous power.

The power house is being built of stone, with a steel frame, and lined with enameled brick. The steel roof of trusses of over 60 feet span rests upon steel posts that serve to carry the girders to sustain a 50 ton traveling crane which commands the entire floor. At the north end of the house the width will be greatly increased, and an L added, extending eastward to the edge of the canal. This L and the enlarged extension of the main building will form the entrance front and will present gable ends to the east and west. To the left of the entrance archway the offices, four stories in height, will be located, wholly in the L, while to the right, including the archway, the whole height of the power house to which it is attached consists of one large room, all accessible to the traveling crane. An arched portal or main doorway of great height forms the entrance vestibule, through which cars loaded to the limit of railway regulation can readily pass into the main power house, through a second lower archway, which in summer will be closed with iron grill work and in winter by doors. Above this second arch will be a medallion of the Indian Chief Ni-a-ga-ra, standing in his canoe shooting the rapids, which has been adopted as the seal of the company. The entrance to the offices is in the left wall of the vestibule, and gives access also to visitors, who, passing a ticket office, gain by an easy flight of stairs a bridge that crosses the great end room of the power station, from which the whole interior may be seen. In this large room will be located the switchboard and testing instruments.

The distribution will be through underground conduits extending in various directions from the station to the principal points of service. A photograph of the conduit in course of construction is shown in the upper left hand panel of the engraving on the opposite page. The conductors will be carried on insulated brackets on both sides. A track extends throughout the length of the conduit, upon which an electrically propelled car will carry the linemen between wire screens that protect them from the dangerous currents through which they pass and allow every portion of the line, brightly illuminated by the passing car, to be thoroughly inspected with absolute safety. The brackets are located 30 feet apart. The concrete casing is made of three parts gravel and one part Portland cement.

One of the largest and earliest consumers of power from this station will be the Pittsburg Reduction Company, whose plant will be located about 2,500 feet from the power house. They will use a current equivalent to about 3,000 horse power in the reduction of aluminum, and light and power will be furnished as fast as the generating and transmitting plant can be put down, not only to the factories which will be erected upon the surrounding land, but to Buffalo and the surrounding country. Experiments are being made to determine the practicability of its use in propelling the boats on the Erie canal. Electricity is the method most in favor for distribution, although Professor Unwin, who is identified with the work, says that power can be transmitted by compressed air to a distance of 30 miles in a 30 inch main, with an efficiency of from 59 to 73 per cent. if reheated, and 40 to 50 per cent. if used cold. In blocks of 500 horse power or less motors will be used. Groups of wheels arranged in sets of five to each pit will be arranged to give power in blocks of 1,000 horse power to a single manufactory, or to several establishments that can combine to use that unit. The cost of excavating the deep wheel pits makes smaller units impracticable by direct wheels, but more efficiently supplied by electricity from the large generators through which a multiplicity of small powers may be grouped upon one large wheel.

## A COMBINED WAGON AND BOAT OF ALUMINUM.

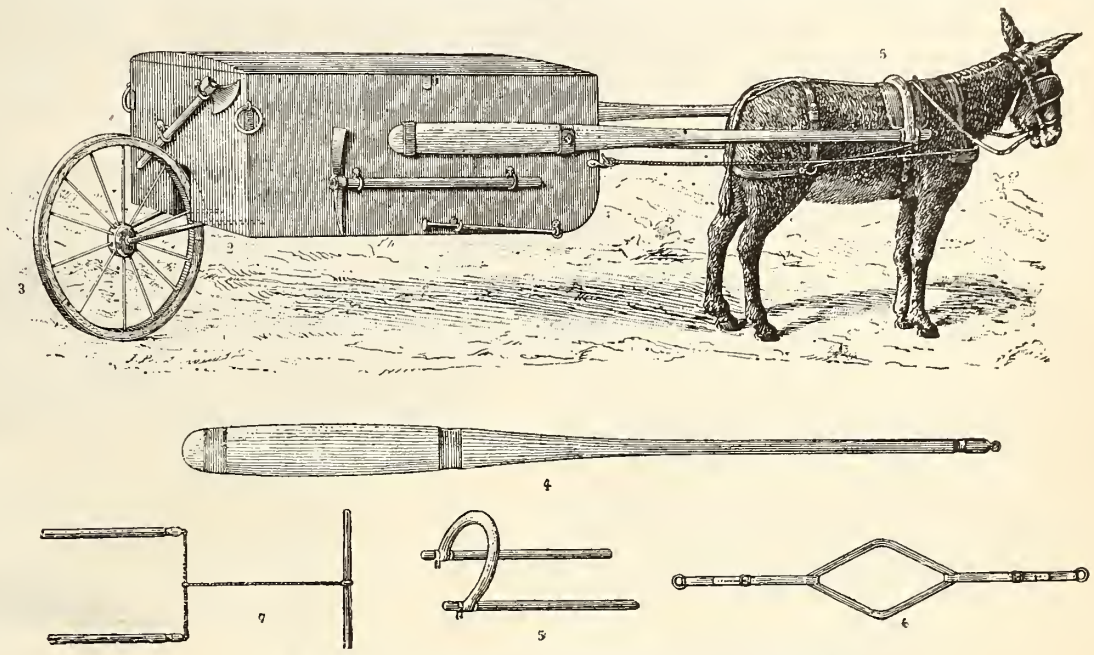
THE combined wagon and boat of aluminum represented herewith are due to the ingenuity of Mr. Jules Claire, a well known explorer.

The wagon, which consists of a tight aluminum box, is very similar to the model used in the Monteil expedition, but differs therefrom in the following modifications.

The very light cover (Fig. 1) is reduced to the least weight possible. The box is provided with an aperture behind (Fig. 2) in order to allow the wheel to pass. The vehicle is mounted upon a single wheel Fig. 3), 3·28 feet in diameter, made of hickory, an extremely strong wood, that permits of giving it but a slight width. The thills (Fig. 4) are formed of the oars designed for rowing the boat. A stiff hame of aluminum (Fig. 5) permits of fixing the thills firmly to the saddle of the ass or mule employed. A breast collar of leather (Fig. 6) is designed for the replacing of quadrupeds by man.

The advantages of this system are greater lightness of the vehicle, which two men would suffice to transport in case of need. The use of a single wheel placed in the rear, capable of being easily carried by one man, reduces to three the number of carriers of the complete vehicle, and which is seven at a minimum in the existing models.

But the greatest advantage of this system is that it renders the wagon capable of passing through pathways in which a carrier can walk, and of easily getting over slight obstacles, such as trunks of trees, rocks, etc. Such a maneuver is impossible with a two-wheeled vehicle, not only on account of its greater weight, but because of the spacing of the wheels requiring a sufficiently wide road.




COMBINED WAGON AND BOAT OF ALUMINUM.

The accessories mentioned above permit of the use of beasts of burden or of men, who can be harnessed to the vehicle in unlimited number, thanks to a pole which can be substituted for the thills.

With this new system of carriage it is possible, in a few minutes, to assemble several wagon boxes in order to form a boat whose oars would be the thills. The explorer will thus be able to cross rivers with safety and carry all the luggage of the expedition. — *Le Magasin Pittoresque.*

## PROFESSOR WELLNER'S FLYING MACHINE.

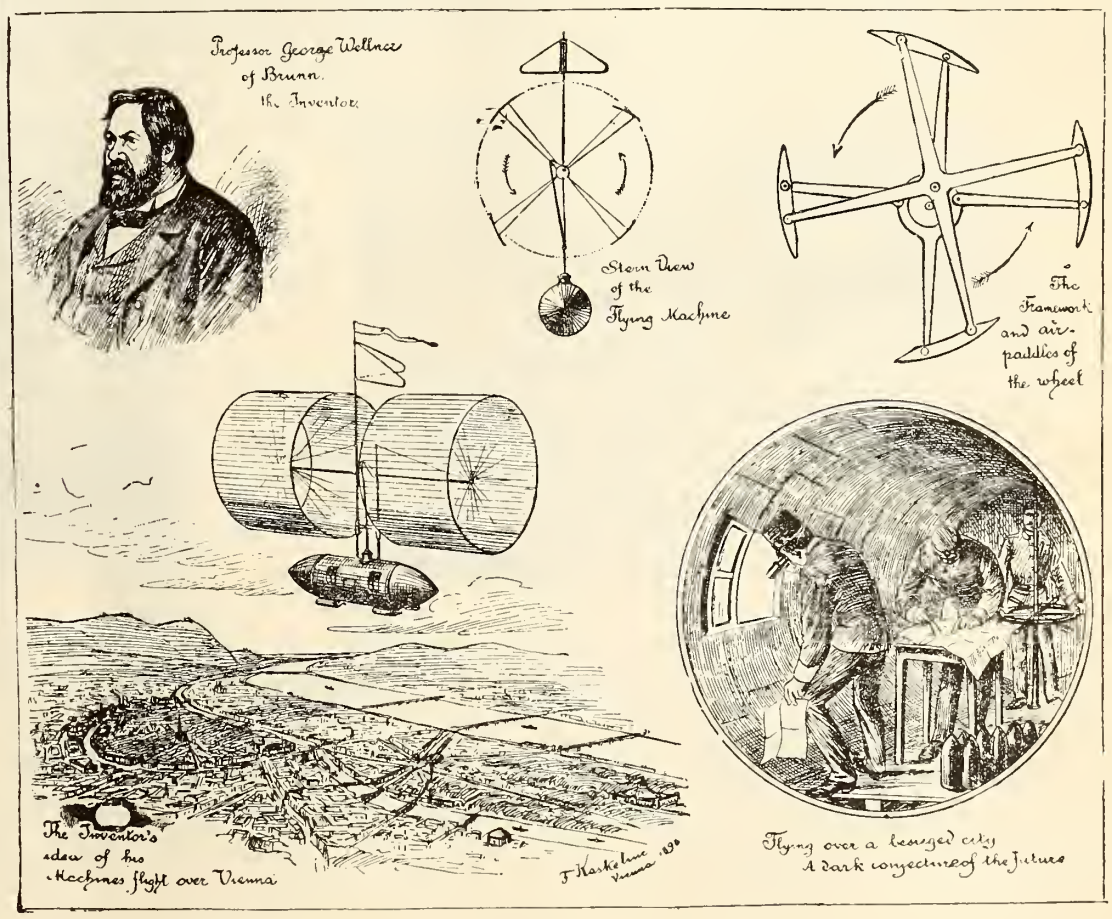
PROFESSOR WELLNER was born at Prague in 1846, and at the Technical School there in 1867 won high honors. He was subsequently engaged as a constructing engineer in several of the big firms in Bohemia. His connection with the Brunn High School commenced in 1876, and on a vacancy occurring during 1886 he was elected to the professorship he now holds. Since 1872 he has visited the various exhibitions throughout Europe. He has written several books. A brochure on "The Possibility of Air Ships," published in 1876, was issued again in substantial book form in 1880. He contributes many articles on technical subjects to magazines. His public work has been confined to the Bohemian Landtag, of which body he was elected a member in 1883.

"I am sorry," observed the professor to us, as we sat together in his house on the Franzen Glacis of Brunn, "that I can only illustrate by diagrams and the models of its parts what I am sanguine enough to consider the flying machine of the future. As you are aware, a sum of money is being raised at present sufficient to cover the cost of a trial machine. This means a delay of a month or so, and then you will be able to definitely judge for yourselves, as the first ascent will probably be made from Vienna. But let me explain to you the construction and principles of the machine.

"My hope of its future success lies in the construction of the sail wheel. It was patented in England in May of this year as 'a rotary sail for flying machines.' It is an invention of my own. The wheel works on a fixed eccentric, and the air blades attached to the spokes have thereby an oscillating as well as a rotary motion, as this model here shows. Observe that when this air blade reaches the highest part of its circle, and just when about to descend, the oscillation of the eccentric causes it to suck in the air and force it downward into the inside of the wheel. There are four blades to each wheel, and canvas is stretched over the same, giving the resemblance of a drum open at both ends. This is the main secret of the machine—this rotatory oscillating blade motion, that gives it support in the air and a rapid forward motion; the rest are mere details."

"And these mere details are what?" I inquired.

"A small car, a compressed air engine, steering gear, and a crew composed of two individuals—a steersman and an engineer. But this is for a flying machine of the smallest description. I have measurements for machines to carry also four, eight, sixteen, and twenty persons. The latter number is, I think, the safe


Professor George Wellner of Brunn. the Inventor
Stern View of the Flying Machine
The Framework and air-paddles of the wheel
The Inventor's idea of his Machines flight over Vienna
Flying over a besieged city A dark conjecture of the future

PROFESSOR WELLNER'S FLYING MACHINE.

maximum, though greater calculations could still be carried out. For eight persons steam engines must be substituted of at least 200 horse power. Sufficient for a primary trial, however, is the small flying machine to carry two persons. It will cost between £2,000 and £2,500 sterling. It will be constructed out of the finest steel. The framework will be excellently put together, and the tubes will be hollow. The sail wheels possess a diameter of 15 feet and a length of 12½ feet. The cigar-shaped car will be 5½ feet in height inside and 12 feet in length. The compressed air strength of the engine must be 25 horse power, and the entire weight carried—including car, engine, framework, sail wheels, and the two men inside—16 cwt. These then are the measurements.

"Now suppose we are inside the car and ready to start——"

"I'd prefer always to be a spectator," I remarked. "But go on, professor; I am in imagination watching the proceedings inside, through one of the car windows!"

"Good. The car is resting upon a clear space of ground, slightly sloping outward. The engines start at '180 revolutions' a minute, and we soar upward at an angle of 28°. When the car, after an interval of 80 seconds time, reaches an elevation of 150 feet, I signal to the engineer for '135 revolutions,' and then the flight is one horizontal with the earth. At '135 revolutions' the car remains stationary, so far as altitude is concerned."

"And doubtless the speed is terrific," I observe, with interest awakened by Professor Wellner's enthusiastic delivery.

"Yes; pretty fast. I calculate upon a speed of all but 1½ English miles a minute. And thus the car rushes through space. I will guide it with the helm above the sail wheels as a ship is controlled on the sea. It moves to the right or left on the same principle. When I wish to check the speed, without diminishing the revolutions, I open out the helm like a fan. In descending, the angle is the same as when rising, namely, 28°. The car sweeps down on the earth again as lightly as a bird. I expect no trouble from my invention, and I have the utmost confidence in it."

"Excuse my doubting faith, professor, but if something went wrong with the engine's works! What next?"

"All up! Utter ruin! But personally I have no dread of such a contingency, and when the opportunity I am so longingly waiting for arrives, you can judge for yourself."

IN TIME OF WAR.

"And should the air ship ever gain public confidence," continued Professor Wellner, "for passenger traffic between towns, there is another important sphere for its usefulness."

"For war purposes," I interrupted.

"Yes. High in the air it seems only a white shred, and a bullet bores through the wooden air blades or glints off the steel framework. A bullet leaves no such disastrous effects as on the silk work of an inflated balloon."

"May I ask if any European war office officials have been in communication with you?"

"Yes, several. But on this point of the question I'd rather give no information. It will add further horrors to war when daring officers can speed over an invested city——"

"And drop down upon its buildings such commodities as dynamite shells," I added.

"My mind does not follow such conjectures," said the professor, "though I must admit the safe solution of the air ship problem will cause no end of changes and revolutions in every phase of human life."—*London Daily Graphic.*

[NATURE.]

## EXPERIMENTS ON FLYING.

If we imagine the linear dimensions of a bird increased $n$ times, its weight will be increased $n^3$ times. On the other hand, the work necessary to keep it flying will, as Helmholtz has shown, increase $n^1$ times.* Now, we can assume that the power, that is to say, the amount of work that can be done in the unit of time, increases in proportion to the weight, or even less. Helmholtz, therefore, concluded that large dimensions are a disadvantage, and that there is a limit beyond which the power will become inadequate to the increased weight. This limit, in his opinion, is already attained in the largest birds, whose bodies appear to be constructed with the utmost economy in weight, and whose constitution and food seem adapted to furnish the highest power. And he therefore thought it improbable that man would ever be able to fly by his own power.

To these discouraging observations, however, some objections may be raised. First, the work necessary to keep a bird flying horizontally depends largely on its horizontal velocity. It decreases with increasing velocity up to a certain limit, when, on account of the friction, too much work must be spent on the horizontal component of the movement. The air will carry a body moving horizontally better than a stationary one, for the same reason that thin ice will sometimes carry a skater, but break under his dead weight. The moving skater is carried as if he rested on long skates that spread his pressure over a large area. The work which is expended in flying horizontally with a sufficiently high velocity may, in spite of Helmholtz's observations, be quite within the reach of human power. The difficulty, then, would only be to start and to arrive at this velocity, and this difficulty might be met by special contrivances. The size of a flier might therefore be increased many times without losing the possibility of quick horizontal flight, though birds must be able to do without such contrivances for starting and arriving at the necessary velocity.

A second objection is that we see many birds—and especially the large birds—when soaring, evidently doing an extremely small amount of work, or none at all, but nevertheless moving rapidly, and even rising to great heights. It seems certain that the wind must do the work for them. The experiments of O. Lilienthal have shown how this is effected. He has made diagrams of the direction of the wind blowing over a plain, and has found it to be, on the average, three degrees upward.* His idea is that the lower regions of the air are retarded by friction against the earth, and that it is therefore heaped up. Of course the rising air or an equal amount would have to come down again somewhere, and this might take place in calm weather. But, however this may be, the wind in some way or other does the necessary work for soaring birds. With a bird of linear dimensions increased $n$ times, this work, it is true, would only increase in proportion to the surface of the wings, that is, proportional to $n^2$, while the weight increases proportional to $n^3$. But for man there would be no difficulty in constructing the wing surface much larger in comparison than that of a bird.

The principal difficulty would lie in the management of the apparatus, in keeping the surface in the right position according to the variations of the wind, and according to the direction that one intends to follow. Perhaps it is not greater than the difficulty a skater meets with in keeping his balance while moving in the direction he pleases; but the consequences of a wrong movement are worse. O. Lilienthal seems to me to have made a step in the right direction by trying to learn soaring.† The accompanying illustrations, which are reproductions of instantaneous photographs taken in Steglitz, near Berlin, show the way he slides down a slight decline of 10° or 15°. The shape of the wings is not flat, but slightly curved. The experiments recorded in his book, "Der Vogelflug," show that the curved form has decided advantages, both as regards the amount and the direction of the resistance. The wing surface is 15 square meters. It is not safe to take a larger surface before having learned to manage a smaller one. He takes a sharp run of four or five steps against the wind, jumps into the air, and slides down over a distance of about 250 meters. By shifting his center of gravity relatively to the center of resistance he can give the wing surface any inclination, and thereby can, to a certain extent, either slide down quicker, or slacken the movement, or alter the direction. If the wind is not too strong, and the surface of the apparatus not too large, I think there is very little danger in this kind of practice. If it is taken up by a great many people, improvements of the apparatus are sure to follow, and the art of keeping one's balance in the air will be developed. Perhaps this is the road to flying. At any rate it must be fine sport.

Fig. 1.

Fig. 2.

Fig. 3.

* Helmholtz, *Gesammelte Abhandlungen*, bd. I., p. 165.

* O. Lilienthal, "Der Vogelflug," p. 115; see also No. 55 of *Prometheus*, p. 37.

† See his article in Nos. 204 and 205 of *Prometheus*, from which the illustrations are taken.

## ALUM AS A SENSITIZING MATERIAL FOR PAPER.

In the current issue of the *Archiv* Dr. R. Ed. Liesegang details some results he has obtained as an outcome of a study of the so called Niepce phenomena, where the phosphorescence of paper has been believed to bring about various photo-chemical reactions.

In one of Dr. Liesegang's experiments paper was impregnated with potash alum, and by an exposure of three minutes to sunlight such a change took place that those parts of the paper upon which light had acted were able to slightly reduce nitrate of silver; but by a further treatment with gallic acid these exposed parts became quite black, the unexposed parts remaining nearly white.

Paper treated with oxalate of soda, sulphite of soda, arsenite of soda, and several other alkaline compounds showed a similar sensitiveness; while exposures on paper treated with nickel chloride, several organic acids, and sulphate of hydroxylamine gave full brown images on development with silver nitrate and gallic acid, the unexposed parts remaining quite white in these cases.

Liesegang thinks it probable that in the cases just mentioned—the alum, for example—no true chemical decomposition takes place under the immediate action of light, but that light is stored in the prepared paper by a kind of phosphorescence. This view is supported by his observation that the impression of the light is only good for a short period; so that if paper prepared with alum or sulphite of soda is kept in the dark for three hours after exposure, no image is obtained on development.

It must be remembered, however, says Dr. Liesegang, that this disappearance in the dark of the effect of exposure cannot be taken as conclusive evidence of the absence of true chemical action, as we have instance of a similar disappearance of the image in the case of true photolytes—certain bismuth compounds for example.

Pure paper, in the hands of Dr. Liesegang, showed—even after long exposure—no reducing action upon silver nitrate.

When paper is prepared with a solution of sodium nitrate and exposed, an image is obtained on treatment with silver nitrate, followed by gallic acid; the nitrite being oxidized in this case to nitrate where the light has acted.

As bearing on this reaction, Liesegang cites the experiments of Laurent published in 1891, which show an action of light the reverse of that now mentioned. Laurent exposed a sterilized solution of pure potassium nitrate to sunlight, and, after several days, he traced the presence of nitrite in the solution; while samples of a similar solution which had been kept in the dark showed no reaction of nitrite. In a subsequent experiment he found 4·1 cubic centimeters of oxygen were liberated in one particular flask of the nitrite when exposed to light for two months.—*Photo. Work.*

## SOME OF THE ANCIENT USES OF ASPHALTUM BY THE ABORIGINES OF CALIFORNIA.

ASPHALTUM was called chapopote by the Indians before the Spaniards entered California. This is the name also used in Mexico.

It was customary with the aborigines of California to bury with their dead the implements and utensils used by them during their lives.

From the customs of to-day and from exhumations made in ancient burial places, the following described uses of asphalt by the Indians have been observed.

A basket without a bottom, made of closely woven grass, was cemented to a flat stone with asphaltum, as shown in Fig. 4. This was employed as a mortar. The Indians gathered acorns, hulled them, and then placed them in a bowl-shaped excavation in the ground. By the aid of water the tannin in the acorn was dissolved and removed by the water slowly percolating into the earth. The acorns were then dried and ground into flour in these mortars with a stone pestle, and, like the practice of to-day, made into a dough and baked.

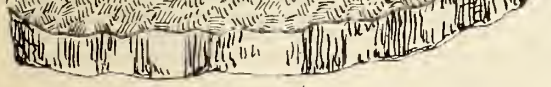


Fig 4

Baskets made of grass were made water tight by a coating of asphaltum. The asphaltum, together with hot stones, was placed in the basket and the basket was turned and caused to oscillate until an even coating was formed.

Baskets were made of tule in the form shown in Fig. 5. The tules were quilted with tarred fiber, asphaltum, with hot stones, was placed in the interior of the basket, and the basket rolled and turned until an interior coating was secured. These baskets were used for water jars.

Mortars were frequently hewn from solid sandstone. These were often accidentally broken and their repair was effected by sticking their fragments together with asphaltic cement, Fig. 10.

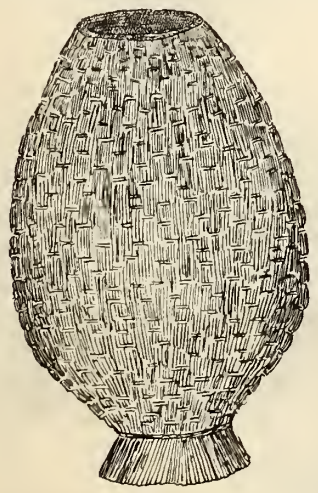
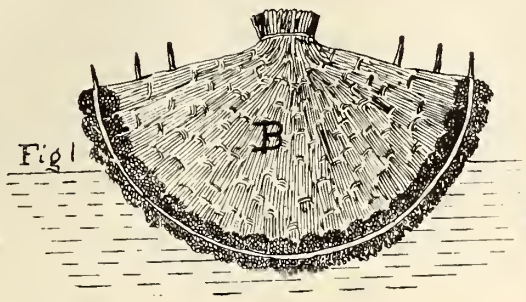


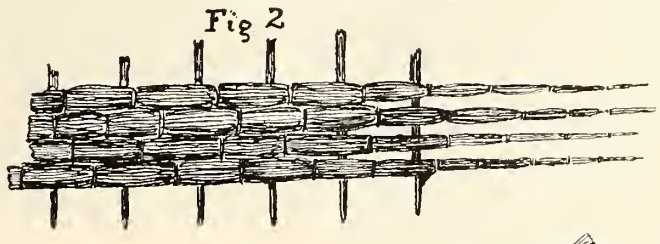
Fig 5

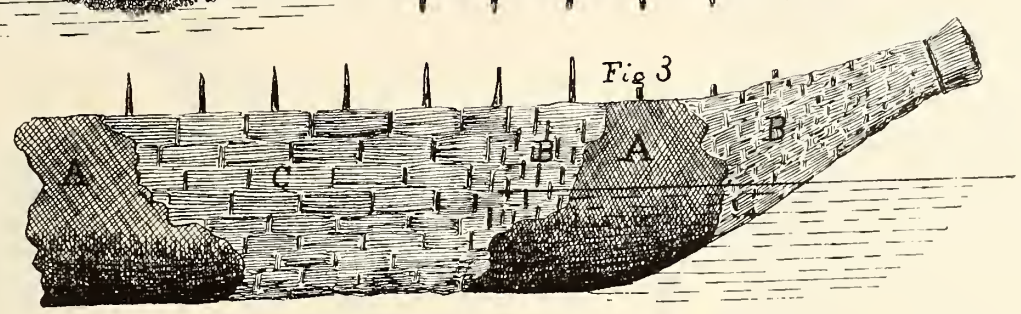
### DETAILS OF BOAT CONSTRUCTION.

Tules were firmly and closely tied with fiber taken from different plants and tarred with asphaltum into bundles about four inches in diameter in the center and tapering to a point at the ends, and of the length of the intended boat.

Pliant sticks, which were intended to act as the ribs of the boat, were shoved through the bundles at intervals in the manner indicated in Figs. 1 and 2. After a sufficient number of bundles of tules and pliant sticks were placed together, they were bent and secured in the form of the main body of the boat. The bow and stern of the boat were then made in the form and manner shown in Figs. 1 and 3. The tules were then quilted with the tarred fiber until they were firm and watertight, B B B, in Figs. 1 and 3.




The bent position of the ribs was maintained by seats. Further rigidity was given to the boat, if necessary, by fastening poles lengthways of the boat to the ribs. The outside of the boat was then smeared with liquid asphalt of the consistency of heavy tar, A A, Fig. 3.

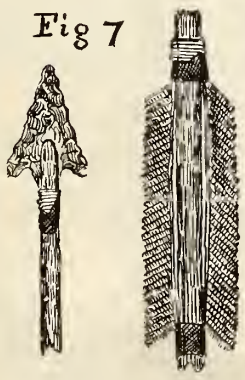
This tar rises in the ocean and floats to the shore in the right state for this use. The surface of the asphalt was rubbed with dry powdered clay to remove its stickiness.

These boats, though cumbersome in appearance, were very light, the main weight being the asphaltum and ribs.

Excursions were made in these boats to the islands, twenty-five miles distant from the mainland. Asphaltum was taken to these islands, where none exists, and steatite, from which their cooking utensils were constructed, was brought back. No steatite exists on the mainland, notwithstanding that it was in common use. These boats were also used for hunting and fishing.

Some of their fish hooks were made from sea lion teeth, Fig. 8. The tooth was notched, as shown in the figure, and bound to a piece of wood with sinew or gut. The sinew or gut was then coated with asphaltum, so that the water would not reach the sinew or gut and cause it to stretch.

The obsidian arrow heads and feathers were fastened to their arrows with sinew or gut, and protected from the action of moisture by asphaltum, Fig. 7. Spear heads were also fastened in this manner. These arrows and spears were poisoned in the following manner: A rattlesnake was provoked so that it would bite a deer's liver. The poisoned liver was then placed in the sun until it became green and putrid. The arrows and spears were then dipped into this corrupted mass. This poison only acts when taken into the circulation of the blood, and, therefore, it did not injure the meat for eating.



Knife blades of obsidian were attached to wooden handles with asphaltum, Fig. 6. These knives were used for skinning animals.

Stems of pipes were fastened to serpentine bowls with a mixture of clay and asphaltum, Fig. 9.

Heads were made on wooden and bone pins with asphaltum, Fig. 11.

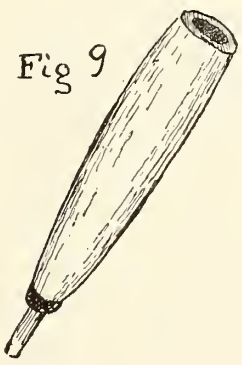
Asphaltum was stored and transported in bivalvular shells, like the clam and mussel.

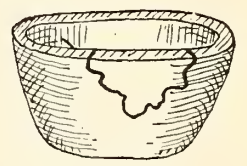
The length of the column of air in their whistles, which were manufactured from a hollow bone taken from a pelican's wing, was regulated by an asphalt plug.

When the wood which they used for fuel was wet by winter rains, it was dipped into asphalt tar springs to make it more combustible. Indian cooking utensils are found in the neighborhood of all bituminous springs.

These tar springs were the fire works of the Indian boys. When set on fire, huge convoluted columns of dense black smoke were seen by day, and the brightness of their flame by night. All of these springs are coked by repeated fires.

Santa Barbara, Cal., January 4, 1894.






## THE ARTIFICIAL PRODUCTION OF PETROLEUM.

By Dr. C. ENGLER.

SCIENTISTS have discussed very often in the last few years the question in which way petroleum, this source of wealth, with its special scientific interest for America, was formed by nature. According to one theory, it is generated from inorganic materials. Sokoloff thinks that petroleum was produced during the period of the formation of our planet out of cosmical hydrocarbons which, in the beginning dissolved in the soft mass, separated from it later on. Mendelejeff assumes that water entering by fissures and chasms the interior of the earth came in contact with melting carbide of iron and produced so in a simple manner oxide of iron and the hydrocarbons of petroleum. Strong objection cannot be made to these two theories from the chemical standpoint; but the composition of the different kinds of petroleum is against them, and geology considers them not free from objections.

For a series of years the idea that petroleum was produced from the remains of plants by a kind of distillation process was most generally adopted, especially by chemists. Chemical and geological reasons are against this theory. From the chemical standpoint it seems quite impossible that the substance of the plants could be split up by distillation into petroleum without leaving charcoal or coke. There would also be a genetic connection between coal and petroleum; but in occurrences of the ordinary kind, coal is nearly always absent. If this were really the case, then there ought to be with every oil occurrence in close connection a coal bank, which really seldom happens.

By a third theory the remains of animals form the raw material from which petroleum is formed in nature. There are many facts proving the decay of masses of animals which we find now in banks in the crust of the earth in the form of the remains of shells, fishes, saurians, etc. Prominent scientists, among them the Americans Wrigley, Whitney, Hunt, and others, and in Europe Hofer and Ochsenius, especially defend this

idea on geological grounds. But I will not enter into the geological discussion, preferring to try to give an answer to the question: How can the transmutation of animal remains into oil be imagined?

In order to answer this some thousands of salt water fishes and also shells have been distilled under strong pressure. The result was a liquid, containing mostly nitrogenous bases, such as pyridin, which was little or not at all similar to petroleum. I then recalled some experiments of Wetherill and Gregory, who found that the wax found in cadavers, the so-called "adipocere," was nothing else but the fatty residue, which remains after the putrefaction of all the other animal matter, especially of the nitrogenous constituents of the cadaver. It is also well known that even fossil bones frequently contain fat. The question now raised was this: Could not the process in nature have been a similar one; should not first of all the nitrogenated animal substance have been destroyed, leaving the fat, which was then transformed into oil? In order to prove chemically this possibility, I submitted animal fat (train oil) to distillation—first in a sealed glass tube, later on in a large iron vessel—under a pressure of twenty-five atmospheres at a moderate heat (300–400° C.), and to my great delight found that under favorable conditions seventy per cent. of the train oil was transformed into petroleum. This equals ninety per cent. of the theoretical output. Besides the oil some water and some combustible gas was always formed. The same behavior has been shown by other fats like butter, the fat of hogs, artificial fats, also the chemically pure glycerids of the fats like tri-olein, tri-stearin and the free fatty acids. All could be transformed into petroleum by distillation under pressure, when managed in the proper way.

I have here a liquid which is the distillate of the fish oil, and I have isolated from it almost all the hydrocarbons which have been discovered in the petroleum of Pennsylvania. The other products—the oil burning in this small lamp, too—are oils obtained from the crude material by purification.

But not only illuminating oils are produced. I separated also by distillation those lighter hydrocarbons which compose the gasoline, the ligroin, the benzine, etc. Recently I have succeeded in finding and separating paraffine wax and lubricating oils from those parts of the crude oil which show a high boiling point. This removes the objection of O. Ross to my theory of the formation of petroleum from animal remains. As a matter of fact, I found in the distillate obtained by decomposition of train oil nearly all the constituents which have been separated from the natural crude petroleum, and even the gases, which, like natural gas, consist essentially of marsh gas.

Very recently I have made close investigations on the mechanism or on the chemism of the formation of the hydrocarbons of the petroleum produced by distillation of fat under pressure. These experiments prove that the simpler organic acids split up in the same way, yielding almost the theoretical quantity of the respective hydrocarbon. Thus phenylacetic acid yields toluene. For further details I am obliged to refer you to the actual experiments. I need only remark, that we have to assume that the acids with high molecular weights are decomposed with the production of a number of hydrocarbons.

To recapitulate, it is a geological fact that we find in nature the remains of antediluvian animals, as shells, fishes, saurians accumulated in masses. Whether these animals have been piled up in consequence of a natural super-production in special places in the ocean, or by currents, or in consequence of great revolutions of the earth, this must be decided by geology; but the remains exist.

Now in which manner do the organic substances of these animals become decomposed?

The animal substance consists essentially of nitrogenated material and fat. The former is easily decomposed, the latter is very stable—a fact which has been very well known for a long time, and has been shown again by exact investigations. Therefore we find the wax of cadavers in old graves, therefore the fat in the bones of mammals thousands of years old, therefore the fat on the bottom of the ocean recently found.

Whether and how far the fat was decomposed in this long period by the water splitting up glycerol and forming the free acid, for instance, the fat in the bones of mammals, cannot be answered. Both fat as well as the fatty acids form petroleum, when distilled under pressure.

We can imagine that such remains wrapped in mud and transported by the currents in the ocean easily accumulate, and later on under the pressure of sedimentary layers or strata, perhaps under the influence of heat, too, are transformed into petroleum. This is only one of the many possibilities by which the mechanical process of the transmutation of fat into petroleum may have happened.

Under any circumstances I think I have proved that from the chemical standpoint, the formation of petroleum from animal remains has the greatest probability, as we are able now to transform every animal fat into petroleum.—*Jour. Amer. Chem. Soc.*

## CLOTH OILS IN REGARD TO FIRE RISKS.

By W. McD. MACKEY.

WHEN dealing with distilled oleins, both foreign and distilled from black oil and brown or Yorkshire grease, the chemist is seriously troubled by the mineral oil question, which assumes a fictitious importance owing to the insurance companies' practice of charging a high rate when an oil is classed as containing mineral oil. Thus black oil containing say, for the sake of simplicity, no unsaponifiable matter, may yield on distillation with superheated steam an olein containing a considerable quantity of unsaponifiable hydrocarbon oil, and the amount may be increased by repeated distillation.

Dr. Lewkowitsch found a specimen of Yorkshire grease that he examined to yield, when distilled on the manufacturing scale, 34·54 per cent. of unsaponifiable hydrocarbons.

These hydrocarbons, the result of reduction during the distillation of fatty oils, are liable to be mistaken for added mineral oil. The nature of such hydrocarbons has not been exhaustively studied, but as far as insurance risks are concerned there seems to be little difference between them and mineral oil itself.

As a result of the new departure in insurance rating, the tendency is to depend on the flash point of an oil, the amount of unsaponifiable matter and a certificate of genuineness from the vender. This certificate in the case of recovered oils is usually valueless, as the oil manufacturer has seldom control over the oil finding its way into the seak (spent soap liquor) he buys. Though the flash point test is invaluable, the determination of the unsaponifiable matter gives data of little use as regards fire risk.

The fact that the tests ordinarily applied are inadequate is not owing to the difficulty of finding better, but to the fact that chemists are seldom asked to give their opinion as to the fire risks attending the use of oils submitted to them. The question usually is if the oil will fulfill the conditions of the schedule; and if the examination goes beyond the flash point and determination of unsaponifiable matter, it leads to questions of composition, sometimes incapable of satisfactory answer, and often of no interest whatever as regards actual fire risk.

Hence, also, the oil manufacturer, if he is so disposed, can, as far as insurance interests are concerned, practically sophisticate with impunity in certain directions.

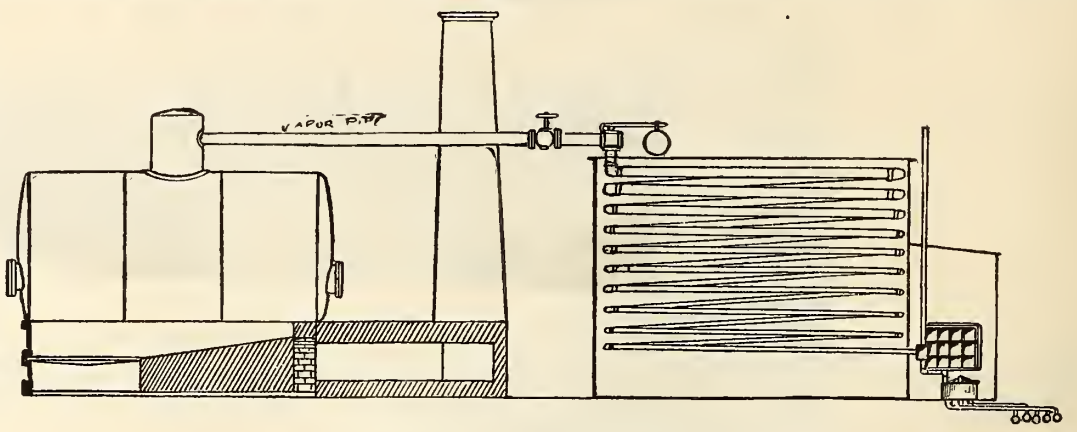
Tests should be insisted on that would indicate the behavior of any particular oil under the conditions obtaining in its use, and there is no doubt that if there were some authority of the nature of Lloyds' in shipping, the testing of oils by rational methods would be undertaken, to the benefit of insurance interests and also those of the cloth and oil trades.—*Chem. Tr. Jour.*

## THE REFINING OF PETROLEUM OIL.

IN spite of popular inveighing against monopolies and popular clamor for legislation against trusts, a thoughtful examination of the work and practice of the Standard Oil Company, the representative trust of them all, will show that they are not without their benefit to the public. The removal of what is often a ruinous competition has not only enriched the refineries, but has also cheapened their product to the public. Instead of religiously guarded trade secrets, we find the various superintendents conferring on what are the best methods of pursuing their occupation. Experiments are carried on by a common fund and the results given to all members of the trust, and in this way the best results are obtained at the very least outlay. The general practice of the various refineries is almost identical, excepting that those of more recent construction are a little improved in the mere detail. All dimensions given in this article refer to no particular establishment, but are merely average good practice.

The process of refining consists in the division and redivision of the crude oil into the various components and then purifying and refining the product. The petroleum products naturally divide themselves into three main groups; the light, nearly colorless, and highly volatile benzines and illuminating oils; the heavy more or less deeply colored paraffine oils and wax, and finally the residuary coke. The first are distilled directly from the crude oil, a heavy black "tar" remaining as a residue in the stills. The second are distilled from this "tar" and the coke is left as perfectly dry residue.

For the first or crude process the apparatus used consists of a still, a condenser and a receiving house, with its accompanying paraphernalia. The crude stills are plain cylindrical vessels 13 feet in diameter and 30 feet long. The condenser tanks are 30 feet in diameter, one tank serving two stills. These are arranged in batteries as shown. The firemen are stationed between the stills, and the stillmen occupy the receiving houses. The stills are of ⅜ inch riveted steel, plain cylindrical, with dialed heads, surmounted by a dome from which a vapor pipe leads. There is, besides, a filling pipe for crude oil and a tar pipe for pumping off the residue, and a manhole in each head for cleaning and repairing. Either in the top of the dome or at some point on the vapor pipe is a safety valve set to blow at a pound to one and a half pounds pressure. The setting is the simplest possible. There is no return flue. The still rests on brick work built up to the middle, the heating surface being about

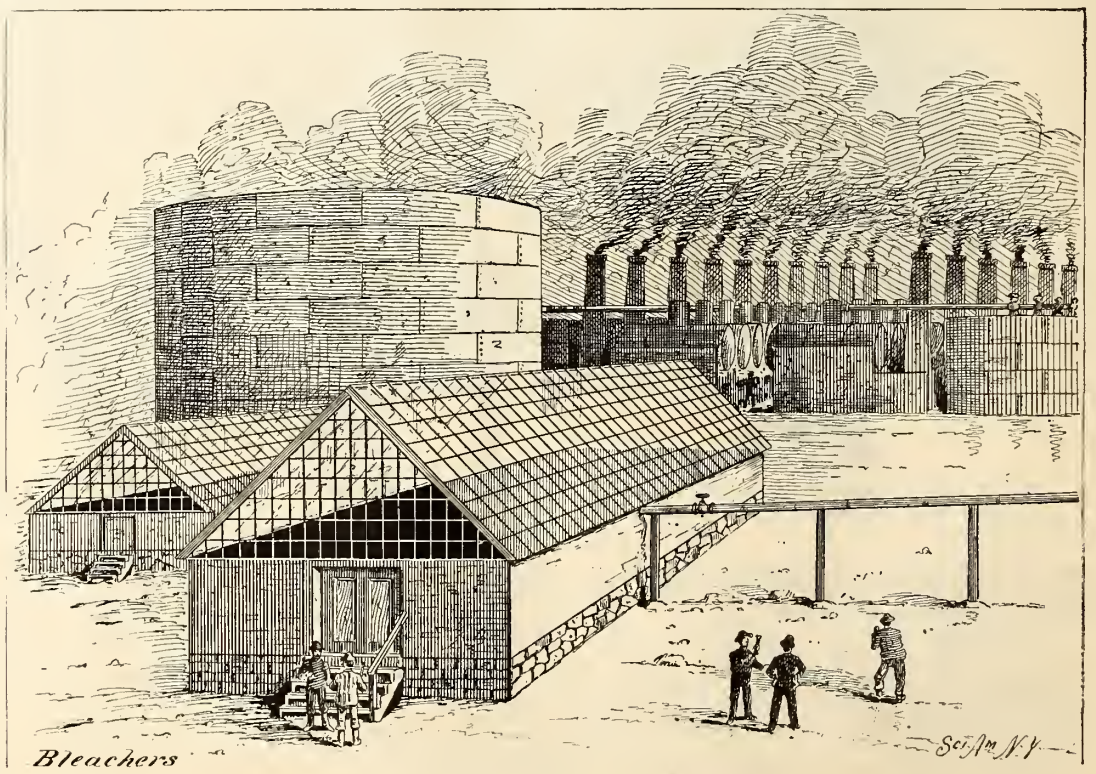



STILL AND CONDENSER.

half the cylindrical area of the still. The upper half is often jacketed with corrugated iron, with about a nine inch air space.

Each condenser contains two square coils of pipe, one from each of a pair of stills, gradually reducing from the nine inch vapor pipe to the three inch pipe entering the running box in the receiving house. This is a small glass-fronted box, where the flow of the oil and its color can be constantly watched. From this box lead two pipes; one from the top, which carries the gas arising from the oil back to the grate to be burned, and the other from the bottom, which carries the oil to the "monitor." The object of this last apparatus is to distribute the oil into the several lines, whence it flows into the various tanks. The oil flows into a box inside the monitor which can be revolved by a handle, so as to bring a nozzle in the bottom of the box opposite the openings of the various pipe lines placed around the circumference of the bottom of the monitor. These lines are: Light benzine, heavy benzine, water white distillate, standard white distillate, etc., depending upon the number of grades of oil desired.

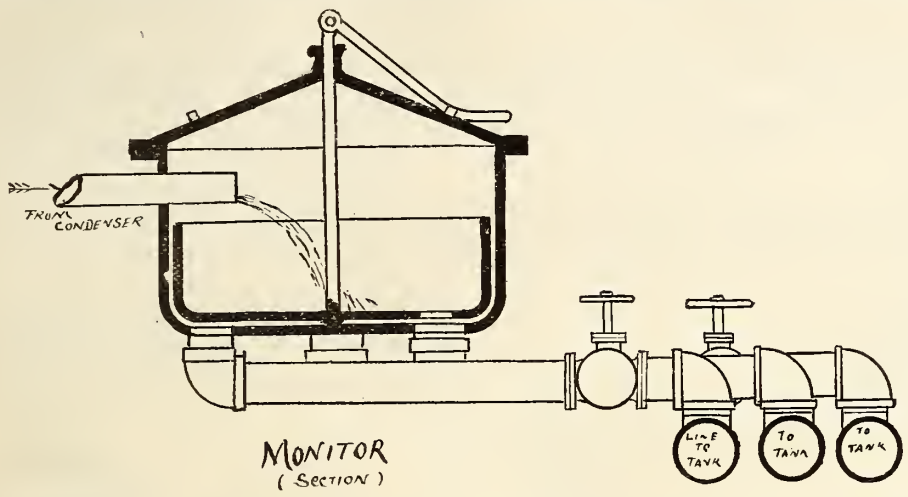
The stills are filled while cold with about six hundred barrels of crude oil and the fires started and continued with ever-increasing intensity for from fifty to sixty hours. At the last stages the bottom plates of the stills are red hot. When the oil begins to flow in the receiving house, the stillman draws off a sample into a cylinder glass and takes the gravity with a Baume hydrometer. The monitor is now set at the lightest "cut," say, for example, the "light benzine cut." He continues to take these samples from time to time, until the oil gets too heavy for "light benzine," when he turns the monitor lever so as to run the oil into the heavy benzine line. In this way he continues through all the various grades down the scale, there being a waste pipe running from the monitor, so that if at any time the oil should run bad, it can be switched into the




REFINING OF PETROLEUM OIL.

waste tauk. After the run is finished the fires are allowed to go out; the residuary "tar" pumped into a large tar tank; the still opened, cleaned, and inspected and made ready for a new run.

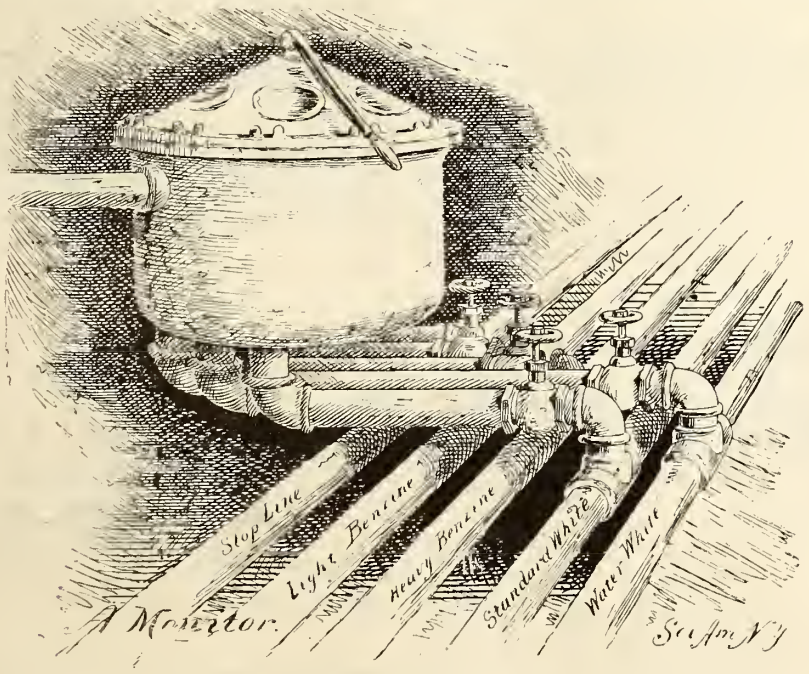
The products of this process are still very crude. The oil is not clear and has a foul odor. The first is caused by the presence of paraffine carried over in the process of distilling, which gives the oil a cloudy appearance, and if allowed to remain, would char the wick in burning. The second is caused by the presence of certain light hydrocarbon oils which, besides their unpleasant odor, are objectionable as being highly volatile, and consequently dangerous. These volatile oils are removed in steam stills, large jacketed stills containing about one thousand barrels and traversed by numerous steam pipes. No fire is used under these stills, the vaporization of the light impurities being accomplished by the steam. It is drawn




off through a vapor pipe, as in the former process, and condensed and purified is the commercial benzine. The partly purified oil is now pumped from the steam stills into a receiving tank and is ready for the process which removes the paraffine impurities.

This is accomplished in an apparatus called an agitator. This is a tank about ten feet diameter, with a funnel-shaped bottom, and fitted with three pipe lines, one for oil, one for sulphuric acid, and the third for water. The oil is pumped into the agitator, sulphuric acid is added, and the whole thing "agitated" by blowing air up through it by means of a small blowing engine. The acid acts as a solvent on the paraffine, and, on stopping the blowing, settles to the bottom, dragging down the impurities in solution. There is no difficulty separating the oil and acid, as, after settling, the latter is easily drawn off through the funnel-shaped bottom with no material waste of oil. Water is now added and the mixture again agitated to wash out the residuary acid, the contents drawn off into settling tanks and thence into the final receiving tanks, whence it is sold as a finished product under the various names of gasoliue, naphtha, headlight oil, astral oil, water white, standard white, ship oil, etc., depending on the gravity, flash, fire and color tests and on the place of manufacture.

The paraffine oils and wax are extracted from the "tar" residue of the crude stills by a process differing only in detail from that of extracting the lighter oils from the crude. The stills are smaller and the monitor not used; instead of one grade at a time, several grades




of oil are distilled at once; the oils being heavier and less volatile, higher temperatures are used, the stills being white hot at the end of the run, naturally the oils also liquefy at a higher temperature. The construction of the still proper is about the same as that of the crude still, but the condenser differs. On the vapor pipe, a few feet from the dome of the still, there is an iron pocket or trap From this pocket a pipe leads to the receiving house and carries the heaviest grade of oil, which condenses as soon as it leaves the high temperature of the still. The condensing coil then takes a couple of turns through the air and has another pocket before entering the water in the tank. These pockets are placed at various intervals along the coil, and in them the several grades of oil collect and flow to the receiving house through separate lines. Of course all these lines will not be yielding at the same time, as at the beginning of the "run" only the lighter oils will be coming off and at the close only the heavier grades, still several grades are condensed simultaneously.

By this process all grades of paraffine oils are made, from the light red oil down to the heavy dark green oil used for only rough lubricating, such as car axles. The residue in the stills from this process is a perfectly dry and very excellent coke, which is clipped out of the still as soon as it is sufficiently cool.

The "chill point" of oil is that temperature at which the paraffine wax "crystallizes" out from the oil. It is by reducing the paraffine oil below the chill point that wax is extracted. A chilling box about eight feet long, six feet square at the front end, and four by six in the rear, with an inclined bottom and movable front, is used. The box is divided into sections by twelve iron partitions, through which brine, chilled by the ordinary form of ammonia refrigerating plant, is circulated. The oil is pumped into these boxes and the brine is circulated until the oil becomes thoroughly "chilled," it is then of the consistency of, and exactly resembles, vaseline. The front of the box is now removed and these immense slabs of vaseline-like substance are slid out and fall into a hopper, at the mouth of which are rapidly revolving knives which cut up the slabs into small bits. From the knives the chilled paraffine is inclosed in canvas and placed in a hydraulic press, where, under a pressure of about two thousand pounds per square inch, the oil is pressed through the canvas and the wax remains. The wax that comes from the canvas bags is hard, firm, brittle and of a light yellow color. This, after being decolorized, is made up into the familiar paraffine candles and other countless uses for which it is fitted, perhaps even including chewing gum.

The oil that comes from the paraffine press is a very fine light lubricating oil, used for light-running machinery, such as that of a spinning mill. Paraffine oils are not purified in the same way as are the illuminating oils; the only process they are put through is that of bleaching. The bleachers are houses closely resembling greenhouses. They consist in a shallow tank surmounted by a gable-ended glass roof. Here the oil is agitated by a constant flow of steam and the bleaching action of the sun does the rest. In this way from the crude oil is obtained this remarkable range of products, nothing going to waste, and extending through an unbroken series from the gases through the volatile colorless gasolines and benzines, illuminating oils, lubricating oils, light in color and gravity, down to the dark heavy oils, and ending with solid black coke. D.

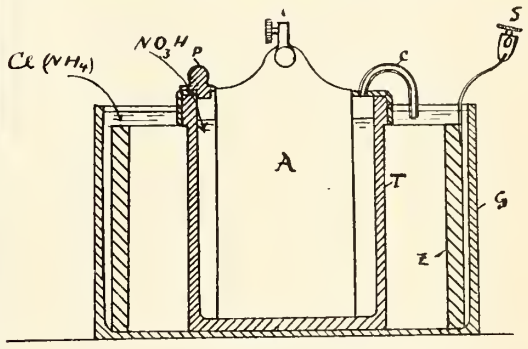
## RHEA FIBER.

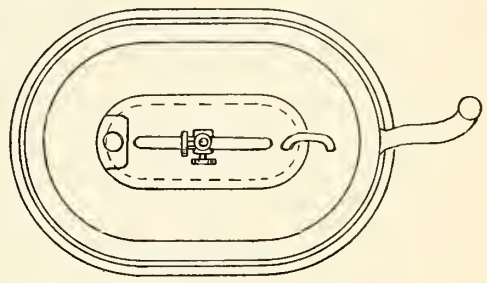
THE Indian Husbandry Company, Limited, has, according to the *Indian Forester*, acquired 209 acres of suitable land about an hour and a half's railway journey from Calcutta, and is in treaty for another 800 acres close to the former plot, on which to grow and manufacture rhea, flax, jute, hemp and other products on a commercial scale. Rhea is an indigenous perennial plant propagated by roots, cuttings or suckers, and yields in some places five crops in a year. Its fiber is placed in a pre-eminent position by its inherent physical properties: fineness, length, luster, strength, lightness, durability, and resistance to water, and which favor its application to various textile fabrics. It is already being converted in Europe into imitation silk fabrics, handkerchiefs, neckerchiefs, ladies' scarfs, umbrella and parasol covers, waistcloth, etc., etc. It stands a strong rival to the finest varieties of flax, and in canvas and sail cloth its superiority over flax is undoubted. It admits of advantageous admixture with wool as well as silk, and the "noils" or the waste of the fiber, when cut into lengths of two inches and mixed with cotton in the willow machine, render the yarn stronger and shining. Mr. J. Cameron, superintendent, Botanical Gardens, Bangalore, states that he has been selling rhea rooots at a nominal charge of R25 per 1,000, and that he still has several thousands in stock, and could easily increase the nursery stock enormously. The chief interest taken so far in the extraction of rhea or ramie fiber from *Boehmeria Nivea* has been centered at Belfast. It is stated that the Bank of France recently had a new issue of notes printed on paper made of this fiber.

## ALUMINUM BATTERY.

My object in introducing this battery, the most powerful of all I have devised, is that I want to give to electrical amateurs and experimenters a galvanic battery by which they, in a cheap and practical way, get in possession of a very powerful and handy source of electricity of very constant current. Here I will mention that concerning its application to electric light I can give a clear proof that even the most perfect galvanic battery will always be much more expensive for electric light than a small dynamo driven by steam or gas. The battery was tested when it had its original shape, for which I obtained a patent. Before I am going to describe it as it is in its new and greatly improved shape, I will give the results of this test, because that involves the principle and is the base for its later design as an aluminum battery.

The tested battery was of cylindrical shape, and of



rather small dimensions. It consisted of a glass 3 in. external height and 2½ in. external diameter. Within the glass was a zinc cylinder immersed in a saturated solution of sal ammoniac. Within the zinc cylinder was a porous jar. Its external height was 2½ in. and its external diameter 1⅝ in. In this porous jar was a big piece of carbon and nitric acid. The top of the carbon was paraffined. The soldering on the zinc cylinder was protected.

### THE TEST.

It had an electromotoric force = 1·9 volt and an internal resistance of 0·25 ohm when new, that is before it gave off any current. That is a very little resistance, considering the small dimensions of the battery. Connected to an external resistance of 3·7 ohms, the e.m.f. was 1·75 volts at the end points of the resistance; consequently the electric current was

$$\frac{1{\cdot}75}{3{\cdot}7 + 0{\cdot}25} = 0{\cdot}443 \text{ ampere.}$$

At the elapse of 35 minutes the e.m.f. was 1·7 volt and the internal resistance of the battery was 0·24 ohm; therefore, the current was

$$\frac{1{\cdot}7}{3{\cdot}7 + 0{\cdot}24} = 0{\cdot}432 \text{ ampere.}$$

At the elapse of 40 minutes more [altogether 75 minutes] the results were: e.m.f. = 1·66 volt; inuer resistance = 0·22 ohm, and current = 0·423 ampere.

At the end of 30 minutes more [altogether 105 minutes] the results were as follows: e.m.f. = 1·6 volts, inner resistance = 0·25 ohm, and current =

$$\frac{1{\cdot}6}{3{\cdot}7 + 0{\cdot}25} = 0{\cdot}405 \text{ ampere.}$$

We see of that, that by the work given off hitherto the inner resistance had not at all increased. On the contrary, it decreased a little, which must be due to a slight rise of temperature in the liquids. The battery was now connected to a resistance of such a size that it gave off a current = 1 ampere. By that the e.m.f. dropped to 1·5 volts; the internal resistance being unaltered. The battery endured that through 1 hour without getting its e.m.f. lower than 1·45 volts, and its internal resistance rose only to 0·255 ohm. Now the battery had given off about 1¾ ampere hour with an average voltage of 1·6 volts. At the beginning of the tests the weight of the zinc

was 0·222 lb. At the end of the tests the weight of the zinc was 0·217 lb.; consequently, the loss of zinc was 0·005 lb. The theoretical loss of zinc should be ca. 0·0047 lb., which shows that the battery presents but very little local action. Having rested ca. 1 hour, the e.m.f. had risen to 1·82 volts. The inner resistance was 0·31 ohm. Connected to an external resistance of 7 ohms, then the e.m.f. was 1·66 volts at the elapse of 10 minutes. It worked then during 15 hours, and at the end of this time the e.m.f. was 0·23 volt, and the inner resistance was 3 ohms. Then it rested 2 hours and the e.m.f. rose to 0·73 volt, its inner resistance sank to 2 ohms. After 1½ hours rest the e.m.f. was 1·16 volts; resistance = 2 ohms. Here ended the tests. The weight of the zinc cylinder was now 0·211 lb., which shows a very small amount of zinc consumed compared with the great electric work given off. The weight of zinc consumed was only 0·011 lb. It shows that the "local action" on the zinc is very small. That is not the case by the Bunsen battery or the well-known bichromate battery. Besides, those batteries will soon be exhausted.

It has to be remarked following:

1. During the test the nitric acid was not protected from being in contact with the air; therefore the nitric acid ($NO_3H$) was quickly losing its available oxygen by exposure to the air, and it was too soon reduced to nitrous acid ($NO_2H$).

2. There was diffusion between the two liquids. It could have been prevented by having the level of the nitric acid to be about 1 in. above the level of the sal ammoniac solution.

3. At the end of the test the battery showed the remarkable feature that the level of the nitric acid had sunk a little, while the level of the solution of sal ammoniac had risen a little. This phenomenon is due to the formation of water in the sal ammoniac and effected by the electro-chemical action.

4. But the most important phenomenon was the development of hydrogen in the terra-cotta pot. The hydrogen bubbled up through the acid with increasing force the longer time the battery had worked. When the nitric acid was nearly transformed to nitrous acid then the development of hydrogen was so violent that, by close examination, the top of the pot was like a small fountain, small particles of acid being thrown up in the air in all directions. If I put a lit match to the surface of the nitric acid, then a cracking noise was heard, due to the small explosions of the hydrogen.

5. It must also be remarked that, due to the great difference of potential between zinc and carbon, hydrogen will stick to the carbon with the effect of decreasing the potential difference and of increasing the internal resistance.

Due to the phenomenon that hydrogen is developed in the nitric acid, and that the electro-chemical formation of water takes place in the solution of sal ammoniac, I concluded that the carbon was only a conductor for the nitric acid, which has to be considered as the electro-positive pole, and the zinc is the electro-negative pole. Therefore, I replaced the carbon by a rod or plate of aluminum.

The aluminum battery, as it is shown in the figure, consists of a glass filled with a saturated solution of sal ammoniac, in which is immersed a cylinder of zinc or of aluminum; in the glass is also put plenty of undissolved sal ammoniac, which will be dissolved by and by, when the electro-chemical action is going on, due to the formation of water and due to the rise of temperature in the liquids. Within the sal ammoniac is the porous jar filled with nitric acid, and containing the aluminum plate. The level of the nitric acid is about 1 in. above the level of the sal ammoniac. The top of the pot is closed by a rubber cover, which extends a little below the surface of the sal ammoniac. From this cover is a rubber tube, the one end of which dips into the sal ammoniac. This small tube allows the hydrogen to escape from the jar, and together with the rubber cover it prevents the air coming into contact with the nitric acid. In the lid is also shown a plug of glass or porcelain. By removing this we can renew the nitric acid.

| | | |
|---|---|---|
| $NO_3H$ | means | nitric acid. |
| $Cl(NH_4)$ | " | sal ammoniac. |
| A | " | an aluminum plate. |
| G | " | the glass. |
| T | " | the porous jar. |
| P | " | the plug in the lid. |
| C | " | the small tube through which the hydrogen can escape. |
| Z | " | the zinc or the aluminum cylinder. |
| S | " | the battery screws. |

With zinc cylinder the aluminum battery gives fully two volts. This voltage it keeps surprisingly constant. That is also the case about the current.

There is but little difference of potential between zinc and aluminum, and aluminum does not get attached by nitric acid at a temperature below the boiling point. This is the same phenomenon which happens, for instance, by concentrated sulphuric acid and silver. At ordinary temperature silver is not attacked by sulphuric acid, but when immersed into concentrated sulphuric acid at boiling temperature, then it is dissolved. Therefore care must be taken that the battery does not become hot.

The zinc cylinder can be replaced by an aluminum cylinder; in this case the voltage is 1·8 volts. Neither the zinc nor the aluminum cylinder is consumed by the sal ammoniac for open circuit, but as soon as the current is set up the chemical action starts.

Aluminum is getting cheaper every year. It will soon be cheaper than zinc with regard to volume. It is one of the lightest metals known, its weight being only 2½ times the weight of water. The weight of zinc is ca. 7·3 times that of water. From that we see that for the same weight the volume of aluminum is about three times the volume of zinc. This fact reduces indirectly the cost of aluminum when used for galvanic batteries. We remember that metals are sold by weight. Next there is another economy by using aluminum instead of zinc. In the chemical action of the battery we get evolved two molecules of hydrogen for each molecule zinc consumed, but we get developed three molecules of hydrogen for each molecule aluminum consumed. That means that, for same amount of electric work given off by the battery, we spend more zinc than aluminum, the ratio being as 3:2. We see by the facts given above that the aluminum battery has the highest voltage, the most constant current, the smallest and most constant internal resistance. No other battery of constant current is to that extent economizing with the zinc and the liquids as the aluminum battery.

The aluminum battery is particularly to be recommended for electrical industry on a small scale, due to the cheapness of the first cost and its handiness, which again is due to its great and enduring power.

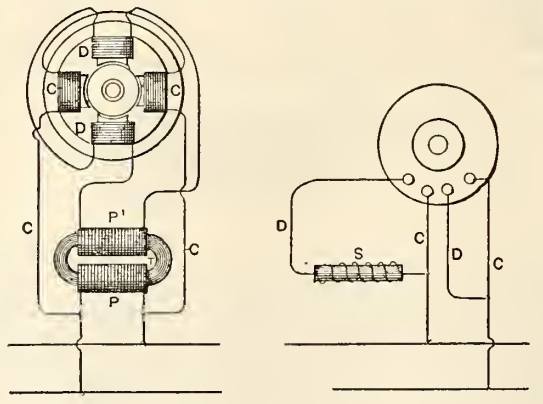
The aluminum battery is particularly to be recommended in all cases where a battery is wanted to overcome hard work.

Applications of this battery will be to electroplating, to telephonic work, to electric boats, to electric fan motors, etc. It can also be used for telegraphic work, but here I should recommend the use of a small dynamo driven by gas or steam or water power. The aluminum battery can be constructed very light and powerful and occupying a small floor space. Due to these facts, it may perhaps solve the problem of the electrical source for an electric flying machine.

To my friends the electric experimenters, and to the electric amateurs, I know that I have now given in hand a gem of a battery. KNUD BENTZEN.

## TESLA MOTORS OPERATED FROM SINGLE-PHASE TWO-WIRE ALTERNATING CIRCUITS.

THOSE who have followed Mr. Tesla's work in alternating motors will recall that in 1888 he first drew public attention to his new multiphase system of ope-



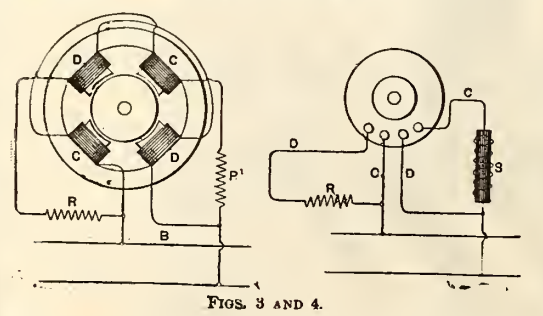

FIGS. 1 AND 2.

rating alternating current motors, in a paper read before the American Institute of Electrical Engineers, in which he laid down the principles which have since been practically applied in many ways. In this system, it will be remembered, each motor contains two or more independent energizing circuits through which are passed alternating currents, having in each circuit such a difference of phase that by their combined or resultant action they produce a rotary progression of the poles or points of maximum magnetic effect of the motor and thereby maintain the rotation of the armature.

A multiphase system of this kind, however, requires at least three wires for its successful operation, to convey the currents differing in phase, and Mr. Tesla, therefore, early set about to devise means for operating phase motors from the ordinary single phase alternating circuit, by creating the difference of phase locally at and in the motor. The various ways in which this can be done are described in two patents just granted to Mr. Tesla, which are of special interest at this time.

In all the methods described below the fundamental idea involved is to pass a single alternating current through both of the energizing circuits of the motor, and to retard the phase of the current in one circuit to a greater or less extent than in the other. The distribution of current between the two motor circuits is effected either by induction or by derivation.

The diagram Fig. 1 shows a motor with two energizing circuits, C and D. One of these circuits, C, is connected directly with the line circuit, while the other set of coils, D, is connected up in the secondary circuit of a transformer, T. The primary coil, P, of this transformer is connected to the line circuit. The al-




FIGS. 3 AND 4.

ternations of current in the line tend to establish in their passage through the coils, C, a polarity opposed to that set up in the coils, D, and if the currents in the two sets of coils coincided in their phases, no rotary effect would be produced. But the secondary current developed in the coil, P, of the transformer, will lag behind that in the primary, which lag may be increased to a sufficient extent to practically obtain the same result as though two independent currents were used to energize the motor.

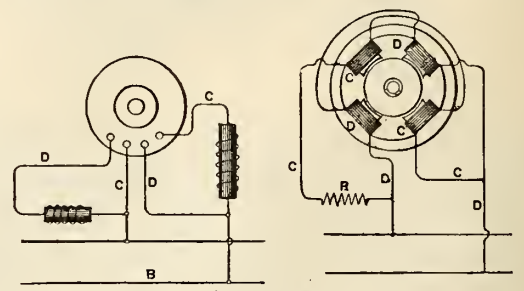
In another form, shown in Fig. 2, the arrangement of the parts is similar to that shown in Fig. 6, except that a self-induction coil, S, is introduced into one energizing circuit of the motor. The effect of thus increasing the self-induction in one of the circuits is to retard the phases of the current passing therein to a greater extent than in the other circuit, and in this way to secure the necessary difference in phase between the two energizing currents to produce the rotation of the motor.

In Fig. 3 there is shown diagrammatically a type of motor in which two dead resistances, R R', are included respectively in the energizing coils of the motor. No rotary effect will be produced as long as the resistances are equal, but by varying the resistance in one circuit the retardation of the current in that circuit will be varied and corresponding effects produced. For example, a reduction of the resistance in one circuit imparts to the motor rotation in one direction, while a reduction of the resistance in the other circuit will produce a rotation in the opposite direction. By means of the two resistances, therefore, capable of variation or of being bodily withdrawn from or inserted in the circuits by simple means, rotation of the motor is secured.

In Fig. 4 a self-induction coil, S, is included in one of the motor circuits and a dead resistance, R, in the other. The increased self-induction in one circuit thus produced acts to increase the difference of phase between the current in that motor circuit and the unretarded current in the line circuit. On the other hand, the introduction of the dead resistance in the other motor circuit reduces the retardation and brings the phases of the current in it more closely in accord with those of the unretarded current, thus producing a correspondingly greater difference of phase between the two currents in the energizing circuits, C and D.

In Fig. 5, two self-induction coils are shown, one in each motor or energizing circuit. One of these coils is much smaller than the other and has less self-induction or counter E. M. F. than the other, so that the phases of current will be retarded to a less extent than in the other.

In Fig. 6 the two energizing circuits of the motor are shown connected in multiple arc to the line circuit, and in one of these circuits is a resistance, R. Assuming the two motor circuits to have the same degree of self-induction, no rotary effect will be produced by the passage through them of an alternating current from




FIGS. 5 AND 6.

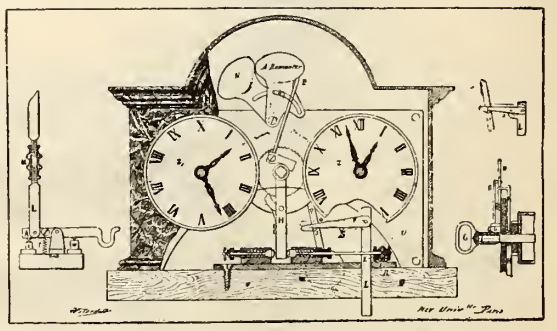
the line. But if one of the motor circuits, as C, be varied or modified by the introduction of a dead resistance, R, the self-induction of that circuit or branch is reduced, and the phases of current therein retarded to a correspondingly less extent. The relative degrees of retardation of the phases of the current in the two motor circuits with respect to those of the unretarded current in the circuit, B, thus produced, will set up a rotation of the motor.

Finally we may mention another type in which one set of energizing coils is of finer wire than the other or has a greater number of convolutions, or each circuit may contain the same number of convolutions, but composed of different conductors, as, for instance, one of copper, and the other of German silver.

Mr. Tesla has devised still other methods for accomplishing the same purpose, but those described will give a fair idea of the wonderful flexibility of the system.—*Electrical Engineer.*

## COUNTER OF TELEPHONE COMMUNICATIONS.

IN certain cities of Europe and America telephone subscribers do not pay a fixed rate of subscription per year, but the charge made by the administration is proportional to the real time during which the telephone is in use. To this effect, there have been established, especially in England, counters that indicate the time in question. The duration of each communication is first registered by the apparatus and afterward all the periods are totalized. This apparatus consists essentially of a clock and an escapement and



COUNTER OF TELEPHONE COMMUNICATIONS.

disengaging arrangement, which is set in motion when the transmitter of the telephone is unhooked and suspended. When the clockwork movement has reached the end of its travel, the subscriber is notified of it by a visible sign, and the telephone cannot be used until after the clock has been wound up. The apparatus operates as follows: The commutator embraces an interior lever, A (figure to the left), upon which is fixed a controlling rod, L, whose length may be exactly regulated by means of the nut, M. This rod traverses the cover, D, of the telephone box and enters the case of the clock, U (central figure). The free upper extremity of the rod, L, carries a hook, F, of extreme mobility, which rests upon a fixed pin, S. The left end of this hook possesses a form such that a pin, *s*, of the pendulum rod, P, effects the lifting of the hook when the pendulum is at the end of its swing, while

the telephone transmitter is suspended, and holds the pendulum rod and stops the clock.

In the upper figure to the right is represented a modified form of the extremity of the rod, L. In this arrangement the pin, S, is replaced by the support, *a*.

At the moment that the transmitter is unhooked and it is desired to use the telephone, the lever, A, is attracted toward the base by the spiral spring, *f*, so that this lever touches the contact, *t*, of the telephone conductor.

Consequently the rod, L, lowers with the hook, E, whose left extremity places itself in the position shown by the dotted line (central figure); the pendulum rod becomes free and the clock begins running.

The motion of the clock is transmitted to the dial, *z*, in the ordinary way, so that one can read thereon the hours and the minutes during which the telephone has been in use. In order to make it possible to register more than twelve hours, one or more dials, $z^1$, are added to the dial, *z*, and the hands are united by means of gear wheels. In this way 1,000 or more hours can be registered.

In order to prevent the telephone from being used before the clock has been wound up, advantage is taken of the diminution of the tension of the spring, C, that occurs when the clockwork movement is stopped. To this effect there is used a claw bar carried by a lever, H, which is capable of revolving around the axis of the main spring of the clock or around any fixed point whatever. The free lower extremity of this stop lever, H, is capable of oscillating between two spring tappets. The tappet to the right, which opposes itself to the pressure exerted by the stop lever, is provided with a stronger spring than the tappet to the left. When, after the stoppage of the clock, the pressure of the stop lever no longer exists, the free extremity of the lever, H, displaces itself toward the tappet to the left, and then, owing to the motion of the spring of the tappet to the right, a stop, R, places itself in the hollow, E, of the rod, L, which latter is blocked in its turn, and the contact of the lever, A, with terminal of the telephone conductor, *t*, is interrupted.

The prolongation, *h*, toward the top of the lever, H (detail to the left), serves to move the sign disk, N, which is habitually found in a position of equilibrium, and is capable of revolving around a pivot. Thanks to the extremity, *h*, this disk is, in fact, displaced from its position of equilibrium, so that it comes in front of an aperture protected by a glass and gives the signal to wind up. Upon introducing the clock key, G, one acts upon a small lever, whose second arm, B, longer and more elastic, pushes the disk, N, back to its position, where it is no longer visible from the exterior, and holds it there while the clock is being wound up.—*Les Inventions Nouvelles.*

[Continued from SUPPLEMENT 943, page 15069.]

## STUDIES OF THE PHENOMENA OF SIMULTANEOUS CONTRAST COLOR; AND ON A PHOTOMETER FOR MEASURING THE INTENSITIES OF LIGHTS OF DIFFERENT COLORS.*

By ALFRED M. MAYER.

*The duration of the time of vision necessary to perceive contrast color.*—A square screen was made, as shown in Fig. 10, with a square of cardboard in its center, 8 cm. on the side, surrounded by a square of translucent white paper, 35 cm. on the side. This screen was placed between the petroleum flame and the window so that its sides were equally illuminated. On the side facing the window the central square appeared cyan blue. One-half of this square was covered by a strip of paper so tinted with orange yellow that it appeared gray when in juxtaposition with the other blue half of the square.

On a rotator was placed two superposed black disks of the same diameter (25 cm.) Near the periphery of each disk was cut out an annular slot, 4 cm. long and 6 mm. wide, as shown in Fig. 11. By turning one of

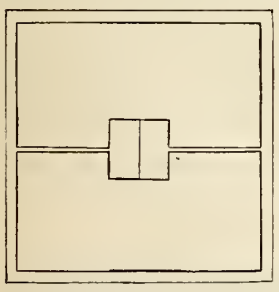


FIG. 10.

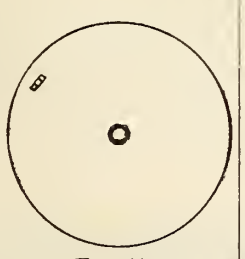


FIG. 11.

these disks on the other the opening of this slot could be varied from 4 cm. to nothing. The rotator is so made that the time of a rotation of the disk can be held uniform and also accurately measured. On gradually narrowing the opening in the slit the duration of vision of the blue and gray square was reduced to $\frac{1}{180}$ of a second, when the blue half of the square could not be distinguished from the gray half.

When the screen was illuminated by a more orange light, obtained by placing a sheet of orange gelatine between the lamp and the screen, the gray and blue were not distinguishable when the duration of vision was $\frac{1}{180}$ of a second.

In these experiments I only got 11·6 flashes of light from the screen in a second, while the number of flashes required to banish all flickering from the screen was accurately measured as 46 in a second with the illumination of the lamp alone, and 42 in a second when the lamp light traversed the orange gelatine film. These experiments show, what is well known, viz., that as the intensity of the light diminishes the duration of no perceptible change in the intensity of the residual impression increases. I found that the sensation of the light from a white cloud seen, near noon, through a north window on a clear day lasts only $\frac{1}{65}$ of a second before the residual effect diminishes.

A gray ring was placed on an emerald green ground facing the light from a bright white cloud. When viewed through the opening in the rotator the ring appeared pink on the green ground till the duration of the vision of the ring was reduced to $\frac{1}{83\frac{1}{3}0}$ of a second, when the ring ceased to be visible on the emerald green ground; but so long as it was visible the contrast color was visible. I found that 43 flashes per second were necessary to render the vision of the pink ring and green ground steady, without the least flickering, while only 11·6 flashes per second were obtained in determining the $\frac{1}{83\frac{1}{3}0}$ of a second as the time when contrast color ceased to be visible. The fact that the contrast color of the ring remained till the ring could not be distinguished from the green ground gave the opinion that I ceased to obtain contrast color because the narrow slit used gave too little light to the eye. On doubling the width of the slit and doubling the velocity of rotation the contrast color of the ring reappeared, though the duration of vision was the same as in the former experiment.

*Experiments on simultaneous contrast colors produced by the flash of the electric discharge.*—The foregoing experiments having proved insufficient to form any opinion as to the time of vision necessary to perceive simultaneous contrast color, I made the following experiments with the light obtained by the discharge of a Holtz induction machine.

1. The gray ring was placed on the emerald green ground near a Holtz machine, which gave a very bright flash of 8 cm. long. The condensing surface on the two jars connected with the electrodes of this machine equaled 135 square centimeters. Professor O. N. Rood* measured the duration of the flash of Leyden jars of 738 and 71 square centimeters of surface, charged by an inductorium. The durations of the discharges of these jars were respectively $\frac{1}{57000000}$ second and $\frac{1}{28000000}$ of a second. From these measures I infer that the duration of the flash of the Holtz machine did not exceed the $\frac{1}{100000000}$ of a second. With short striking distances between the electrodes the flash is formed of several separated acts, as shown by Henry,† Feddersen,‡ Rood,§ and Mayer.‖ In the case of the discharge of a large inductorium the writer ‖ has shown that when the striking distance between brass ball electrodes is only one millimeter, with a Leyden jar of 242 square cm. of surface in the circuit the discharge lasts $\frac{1}{24}$ of a second and is formed of over 120 separate sparks; but as the striking distance is increased the discharge is formed of fewer and fewer components, till at a striking distance between 1 and 2 cm. the discharge is reduced to a single flash. In the following experiments the striking distance is 8 cm., and a single flash was given, whose duration we may safely assume was less than $\frac{1}{100000000}$ of a second.

In a dark room, at night, the flash of this machine gave vivid contrast colors. The gray ring appearing bright pink on an emerald green ground, and of a bright yellow on an ultramarine ground. The after images of these effects lasted about half of a second.

2. A rod was placed in front of a white cardboard and the shadow of the rod was formed on the screen by a candle. The distance of the candle was such that the white cardboard appeared equally brilliant when illuminated only by the candle or only by the electric flash. At the moment of the flash the appearance presented was very remarkable. From the shadow of the candle appeared suddenly to shoot a dark screen, which had superposed the shadow of the candle, and which shot to the side of the shadow and appeared of a bright golden orange, while the apparently uncovered shadow of the candle appeared of a brilliant cobalt blue; to my eye exactly as though an opaque screen had been suddenly removed from a slit in the shutter of a darkened room, which slit was covered by a piece of cobalt glass.

3. A square of thin green glass, 4 cm. by 6 cm., was placed on a piece of thin silvered glass, 4 cm. by 12 cm., so that the edges of the green glass and of the silvered glass coincided. This arrangement gave a surface half of silvered mirror, half of green glass. This apparatus was so placed that the electrodes of the machine and the flash were reflected from it to the eye. The room was dark. At the moment of the flash its reflection appeared as in Fig. 12. On the mirror the line of the discharge was white; W in the figure. The continuation of this line on the surface of the green glass appeared red (R in figure), though really white. In front of and parallel to this line was a green line, G, produced by the light of the flash reflected from the surface of the silvered mirror, and having traversed twice the thickness of the green glass. In this experiment we obtain contrast colors in the source of light itself.

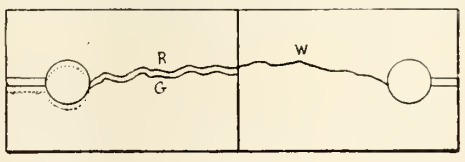



FIG. 12.

*The explanation of the phenomena of simultaneous contrast colors*, as generally given in works on chromatics, is that they are due to "error of judgment," to "deception of judgment," or to "fluctuation of judgment." The reasoning given may be convincing if all the conditions really exist which the writers assume to exist in their explanations of these phenomena. One of these conditions is that a judgment can be formed in the minute interval of time only necessary in which to perceive contrast colors. In the experiments just described with the electric flash we have *apparently* instantaneous perception of the contrast colors in the gray ring placed on the green and ultramarine grounds, in the candle and electric light shadows, and even in the very flash itself when this is seen reflected from the top surface of a green glass and from the mirror on which the green glass rests.

Many careful experiments made by me and others, using as chronometer three pairs of forks of the octave $UT_6$, giving respectively 10, 12, and 15 beats per second, showed that certainly the interval between the flash and the perception of the colors was less than $\frac{1}{15}$ of a second. Indeed, on viewing the flash and the illuminated surfaces at the same time, or hearing the discharge and viewing only the illuminated ring, *no interval could be detected* by this mode of observation as existing between the instant of the flash and the perception of the colors, and we certainly could have detected a shorter interval than $\frac{1}{15}$ of a second had it existed.

It is here to be noted that, although the after images of the contrast colors in these experiments with the electric flash lasted about one-half of a second, yet the most careful scrutiny could detect no change in sensation at and immediately following the flash. The contrast colors, so far as I and others observed, appeared at the moment of the flash. After the instant the image of the flash is formed on the retina there exists, no doubt, an interval of time before we are conscious of the stimulus, whose effects are seen rapidly to rise and then more gradually to fall, falling with two oscillations in intensity, so that all the events of the phenomenon take place in about one-half of a second. However, no vague impression of surfaces merely differing in illumination and then suddenly changing into a color and its contrast color could be detected. I think that this interval of no color sensation, if it exist, must be of exceedingly short duration; but such a period of light without color cannot be detected; and if it cannot be perceived, then, so far as we are concerned, it appears to me that there can be no hesitation in the perception of the colors, and no "fluctuation of the judgment" and "dividing between two images the difference in color which really exists" before the mind reaches its conclusion as to the character of the colors.

The following experiments were separately made on three persons between whom no communication had passed as to the nature of the experiments to be tried on them. I placed a gray ring on an ultramarine disk in front of the Holtz machine and requested the observer, who had explicit confidence in my truthfulness, to describe to me as accurately as possible the exact hue of the pink, or rose color, or red he would see on a green ground at the instant of the electric flash. Each observer at once said: "It is not pink; the ring appears yellow on a blue ground." Now in each of these experiments the observer was prepared, by my pardonable lying, to see red on a green ground; and to see yellow on a blue ground his mental condition of anticipation to see red on a green ground was first removed, then a new departure was taken and a judgment formed which resulted in his seeing yellow on a blue ground, and all that in a minute interval of time.

I do not know if psychologists have come to a conclusion as to the smallest interval of time necessary to form a judgment, either true or false, or in which to have a "fluctuation of the judgment," or in which "to exercise judgment and divide between two colors the difference in colors which really exist." If such mental operations can be performed in the millionth, the thousandth, or even in a few hundredths of a second, then the explanations of these phenomena, as generally given, may be convincing.

Von Bezold, in his "Theory of Color," Boston, 1876, in explaining the fact that a rod seen by reflection from a piece of green glass laid on a mirror gives two images, one green the other red, says: "As the observer does not *know* which of the two images is the colored one he exercises his judgment, and divides between the two images the difference in color which really exists." Now this experiment is similar in its conditions and in its effects of contrast color to the one I made on the contrast colors of the electric flash, when the same colors were distinctly seen apparently at the moment of the discharge. Can one "exercise his judgment and divide between the two images the difference in color which really exists" in an interval of time which is less than $\frac{1}{15}$ of a second?

In the experiment of the colored shadows cast by the candle and by daylight, these colors are explained by Von Bezold (pp. 152, 153), as follows: "The spot occupied by the blue shadow is illuminated by the *white daylight*, the larger white surface by *daylight and by candle light*, the other shadow by candle light only. It might be presumed, therefore, that one of the shadows would appear white, the other yellow. This is not the case, however: for *knowing* the surface to be white, we still take it to be white after it has really received the yellow light of the candle. Our judgment is led astray regarding white, and hence we believe the place occupied by the second shadow to be blue, although it is actually white."

Helmholtz ("Lectures," New York, 1873, p. 267), says: "Thus in the experiment described above of colored shadows thrown by daylight and candle light the doubly illuminated surface of the paper being the brightest object seen, gives a false criterion for white. Compared with it, the really white but less bright shadow thrown by the candle looks blue." These explanations assume knowledge and conditions which are not essential. If this knowledge and these conditions were necessary to see the phenomena, then these explanations of the phenomena might be convincing; but the conditions they assume are not necessary. The following experiments show that there is no necessity at all in "knowing the surface to be white" or to see "the doubly illuminated surface of the paper."

The experiment of the colored shadows cast by the candle and by daylight was arranged behind a screen, so that no one could divine what was there. A tube blackened on the inside went obliquely through the side of the screen, and was so adjusted that the circular field of view through the tube was entirely filled by equal portions of the two shadows, which formed two semicircles, one colored orange, the other blue. The two persons on whom I experimented were ignorant of the phenomena of contrast color and, moreover, were misled as to what they would see on looking into the tube, and I was specially careful not to speak to them about color. These persons were strangers to each other and neither knew that the other had been the subject of my experimenting. The first observer at once reported: "I see a circle half yellow and half blue." The other said: "I see a golden band next to a sky blue band, and the golden band is rather deeper in color where it is next to the blue," which is certainly a very good description.

Having in mind the facts established by the foregoing

* From the *American Journal of Science*, vol. xlvi., July, 1893.

* This Journal, September, 1871.
† Proc. Amer. Phil. Soc., 1842.
‡ Pogg. Ann., vol. cxvi. p. 132.
§ This Journal, Oct., 1872.
‖ This Journal, December, 1874.

experiments, it seems to me that we have either to regard the phenomena of simultaneous contrast color as psychical phenomena of which no satisfactory explanation has been given, or we must discard the Young-Helmholtz hypothesis of color sensation and adopt one similar to that of Hering, which gives a direct physiological explanation of contrast-color effects without the psychological considerations which those who adopt the Young-Helmholtz hypothesis are obliged to resort to in their explanation of these phenomena; and which explanations, as I have attempted to show, are faulty, and have to be modified to be convincing.

According to Hering's hypothesis of color sensations, when a portion of the retina is stimulated, adjoining portions of the field of view are affected by a sort of inductive action; so that changes are produced which are antagonistic or complementary to those portions of the retina actually stimulated.

M. Foster, in his "Physiology," Lond., 1891, Part IV., bk. III., gives an excellent discussion of the relative merits of the Young-Helmholtz hypothesis and Hering's in explaining color sensations. In conclusion he writes: "So far as we are aware, no crucial test between the two has as yet been brought forward. We may now leave the matter with the remark that while the Young-Helmholtz theory tends to lead us direct from the retinal image to the psychological questioning of the sensations, and seems to offer no bridge between the first step and the last, Hering's theory is distinctly a physiological theory, and at least holds out for us the promise of being able to push the physiological explanation nearer and nearer home before we are obliged to take refuge in the methods of psychology."

(*To be continued.*)

[Continued from SUPPLEMENT, No. 943, page 15077.]

## ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

*Lecture III.*†

IN the last two lectures certain methods of investigating molecular change in alloys have been studied. It will now be well to direct attention to some of the effects of molecular movement in liquid, and even in solid metals and alloys. That the atoms of gases are in rapid movement may be readily demonstrated by any of the familiar experiments by which the diffusion of a light gas—such as hydrogen—through a porous vessel of clay increases the pressure in the interior of the vessel. It is less easy to demonstrate the molecular movement in metals, but it may nevertheless be done, as will be shown in the course of this lecture.

It has long been known that the vapor pressure of a liquid is decreased by the presence of salts in it, and Tammann has shown that the molecular diminution of vapor pressure of any one solvent is nearly equal in value when caused by similar salts. For details as to the elaborate investigations which have been made, the student must refer to such a work as that by Prof. Ostwald on "Solutions;" allusion can only be made here to a law of Raoult, which states that "the lowering of vapor pressures of solutions in different solvents is equal when the proportion of the number of molecules of the dissolved substances to the number of molecules of the solvent is the same." Ramsay has shown that this law of vapor pressure applies to metals. He dissolved metals in mercury. Two U tubes were used, each with one short closed limb and one open limb; one tube was filled with the amalgam to be examined and the other with pure mercury.

The two tubes were placed side by side in a bath of mercury vapor, and the difference between the heights of the columns was read off. In every case a diminution of vapor pressure was observed, and there was also evidence that the metals tend to form the simplest possible molecules, that is, molecules consisting of single atoms. The numbers found for the molecular weights of calcium and barium are very noteworthy, as they are about half as large as the atomic weights; the number found for potassium is also much smaller than the atomic weight. Aluminum and antimony show a tendency to form complex molecules, and this fact may be connected with the peculiar behavior already alluded to of antimony and aluminum in forming alloys with each other and with other metals, which bear strong resemblance to chemical compounds.

It may be well to add a brief but somewhat rough explanation as to the diminution of the vapor pressure of a solvent caused by the presence of a dissolved substance.

Take the case of a column of water partly filling a closed glass tube; molecules of water will fly off from its upper surface into the space above and will continue in movement. Some molecules hit each other, some rebound from the sides of the glass tube, while others return to the liquid itself. It will be evident that this molecular movement produces a certain definite pressure, and a state of equilibrium is established when an equal number of molecules leave and return to the liquid in a given time. If a salt is dissolved in the water, there is no longer a free surface of pure water from which molecules are evaporating, that is leaving the fluid, in virtue of their own molecular movement, but the surface is that of a saline solution and not that of a pure solvent, and there will be fewer molecules of water able to escape in a given time, as part of the area of the liquid surface is occupied by salt. There is the same opportunity as before for the bombardment of molecules and for their return to the liquid, but there is less opportunity for liquids to leave the solution; consequently, when equilibrium is established, it will be found that the pressure exerted will be *lower* than before, provided the temperature has remained the same. It will be obvious that the same argument applies to the passage of molecules from a surface of pure mercury compared with mercury containing dissolved metals; the molecules of the metal which is held in solution retarding the evaporation of the mercury, as the salt did that of the water.

It follows that the observed diminution in pressure of a solvent, produced by a given proportion of an added element, should enable the molecular weight of an added element to be calculated, because by the law of Avogadro, the number of molecules in a given volume of all gases is the same under equal conditions as to temperature and pressure; and, further, experiments prove that the small quantity of metallic impurity present in mercury is in a state similar to that of a gas. It follows that having ascertained the diminution of pressure produced by any given element, the molecular weight of which is accepted, it is easy to deduce the molecular weights of other added elements by observing the diminution of pressure they produce.

The view that the mode of existence of an impurity in a solvent is similar to that of gas leads to the consideration of the manifestation of pressure exerted within liquids, whether they be saline or metallic, and to this the name "osmotic pressure" has been given. In attempting to explain this, it is necessary to turn to the effect produced by ordinary saline solutions. Let the porous cell, *a* (Fig. 1), which has a semi-porous "membrane" of ferrocyanide of copper deposited in its walls, be filled with a solution containing one per cent. of nitrate of potash.

The whole cell is then immersed in water, a certain small quantity of which finds its way into the cell, and it will be found that the mercury in the manometer tube will rise thereby, indicating the existence of a pressure of more than three atmospheres within the cell. Pfeffer's* work is the most important in this direction, and to it the student should refer. Now, as Ostwald has pointed out, it was not until Van 't Hoff began to develop a theory of solutions on the basis of such phenomena that clear conceptions of the nature of the forces at work were formed, but in his hands the theory has proved to be very fruitful. First, it has been established that osmotic pressure is independent of the nature of the membrane. The amount of water which enters the cell is very small, and need not appreciably dilute the solution of nitrate of potash; water can, moreover, freely pass in or out of the cell. The osmotic pressure must, therefore, be a specific property of the substance in solution, and in this respect osmotic pressure resembles gaseous pressure.† It is not the place to demonstrate this, but let it be accepted that the molecules of the dissolved body do exert pressure; let us, therefore, examine what is the effect of molecular pressure exerted by a small quantity of one metal dissolved in a mass of a metallic solvent.

The presence of a salt in solution raises the boiling point of the solution, because in order to enable an

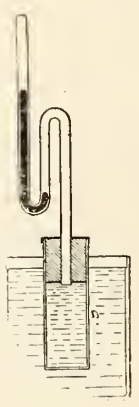


FIG. 1.

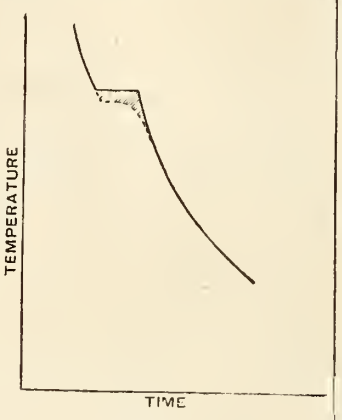



FIG. 2.

equal number of molecules to fly off in a given time from the surface of a *saline* liquid as from a pure liquid (see *ante*), the temperature must be higher, for, as in the previous case of the depression of the vapor tension by the presence of impurity, there are fewer molecules capable of escaping from the surface of the solvent than there would be if the solvent were pure, and in order to produce sufficient molecular pressure, a higher temperature is necessary. Why then should the freezing point of the solution be depressed by the presence of impurity? The freezing point is influenced by external pressure, but is mainly dependent upon internal pressure within the liquid mass. Arrhenius has shown that in a very dilute solution of a salt, the salt is probably dissociated, its ions are free. It can be imagined that in a dilute metallic solution, say of lead in gold, the lead molecules are also free, and the lead molecules, behaving as gaseous molecules, exert very considerable pressure. It has been shown by Pfeffer's experiments, already referred to, that in the relations between a solvent and the dissolved substance very considerable pressure is exerted. Take the case of melted gold containing lead as an impurity. As the mass of gold containing lead is about to solidify, its molecules are striving, so to speak, to come into closer contact, but are prevented by the movement of the molecules of the lead, and before the molecules of the lead can be expelled from the gold ones, these latter must do work. The only energy available is that liberated when the gold changes its state from liquid to solid, and a portion of the latent heat of fusion is employed in doing this work of expelling the lead. The gold, on account of the internal pressure due to the lead molecules, exists as a fluid, at a lower temperature than it otherwise would; and, finally, when the gold molecules are ready to come to rest as a solid, they cannot possess the same kinetic energy as they would if the intruding lead molecules had not been present, because they have done work on the lead. The freezing point of the gold is thus lowered, and the energy for the expulsion of the lead molecules has been drawn from the latent heat of fusion.

In the case of a metallic mass with a small quantity of impurity, the action appears to be as follows: Suppose the metallic mass to be gold, and the impurity platinum. The mass cools and begins to freeze, pure gold separates (the analogue of colorless ice which would separate from a dilute solution of a colored salt), and the dissolved platinum is forced to occupy a smaller space. In order to effect this concentration, work has to be done by the freezing metal, part of the latent heat liberated by freezing is employed on the work of concentrating the platinum. The metal gold can, however, fall below its normal freezing point without becoming solid, if sufficient internal pressure is available to keep it fluid, and this pressure is supplied by the osmotic pressure caused by the movement of the particles of platinum.

The main interest connected with osmotic pressure exerted in alloys is derived from the fact that the presence of a metallic impurity in a mass of a metallic solvent lowers the melting point. It may incidentally be observed that the curves of cooling obtained by the autographic recorder already described are of much interest in this connection, as they afford a measure of the heat liberated on solidification of a pure or impure mass of metal. Thus if the continuous line in Fig. 2 represents the cooling curve of very pure gold, and the dotted line that of gold contaminated with lead, then the shaded area will afford a measure of the heat expended in overcoming the osmotic pressure due to the added lead.

I have extended the work of Heycock and Neville to a solvent with a much higher melting point than they used, and have employed gold as the solvent, the measurements of temperature being made with a platinum rhodium thermo-couple, as has already been described.

It will be obvious that it is a very important advance to have enabled the changes which occur during the cooling of a mass of metal, with so high a melting point as gold, to be recorded automatically.

In my last course of Cantor lectures a description was given of certain attempts to separate the constituent metals of alloys by electrolysis. It was shown in some experiments made by myself that the action of a current of 300 amperes on an alloy of gold in lead, or of silver in lead, entirely failed to reveal the existence of the slightest separation of either of the metals from the lead. Other attempts have since been made by more than one experimenter, but, so far as I am aware, entirely without success. I also attempted to separate aluminum alloyed with gold, in a series of alloys which have since proved to be of a remarkable character; but hitherto the results of the electrolytic experiments have been absolutely negative. Before leaving the experiments connected with the passage of an electric current through an alloy, the following very interesting experiments of E. Warburg and F. Tegetmeier* deserve more than a passing notice. Their experiments would seem to demonstrate the possibility of producing eventually a degree of porosity in vitreous bodies which will admit the passage of elements having comparatively small atomic volumes, while other elements having larger atomic volumes are strained off, thus occasioning a mechanical sifting of the elements. A receptacle, Fig. 3, was

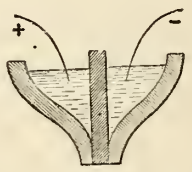



FIG. 3.

divided by a sheet of glass, which could be several millimeters thick. Sodium amalgam was placed on one side, and pure mercury on the other; the whole was then heated to the moderate temperature of 200° C., at which the glass becomes slightly conducting. By the aid of a Plante battery, the sodium atoms of the sodium silicate present were set in motion, and after the experiment had continued thirty hours, it was found that a considerable quantity of sodium, amounting to 0·05 gramme, had passed into the mercury, which was originally pure. A corresponding amount of sodium had been lost by the amalgam; but the glass had exactly preserved its original weight and clearness. The glass was partly composed of neutral molecules of sodium silicate, together with free molecules both of sodium (base) and of the acid, and the free sodium was capable of being transported under the influence of the electrical current. When, however, Tegetmeier replaced the sodium amalgam by lithium amalgam and repeated the experiment, the sodium of the glass passed as before into the originally pure mercury, and the glass became opaque on the side touching the lithium amalgam; but after a time the opacity extended right through the thickness of the glass, and then metallic lithium began to accumulate in the previously pure mercury. It is not possible thus to chase out all the sodium present in the glass; but the *free* sodium atoms are replaced by those of lithium. Analysis showed that the glass originally contained 2·4 per cent. of potassium and 13·1 per cent. of sodium, but after the experiment, while retaining the same percentage of potassium, it had 4·3 per cent. of lithium and only 5·3 per cent. of sodium. The glass in which lithium has thus replaced part of the sodium is very tender, and is opaque and friable. The conclusion is that the atoms of lithium, having an atomic weight of 7 and an atomic volume of 15·98, can pass along the tracks or molecular galleries left in the glass by the sodium atoms, the atomic weight and volume of which are 23 and 16·04 respectively. When a metal of superior atomic weight and volume to sodium is substituted for the lithium—such as potassium with atomic weight 39 and atomic volume 24—it is found not possible to chase out the sodium, the new atoms being too big to pass along through the spaces where the sodium had been. We are thus confronted with a molecular porosity which can, in a sense, be gauged; and the mechanical influence of the volume of the atom is thus made evident.

In this connection an almost forgotten experiment of Homberg's,† and a singular extension of by Guthrie, becomes of much significance. I have elsewhere directed attention to the fact that so long ago as 1713 the Dutch chemist Homberg wrote a remarkable paper "On substances which penetrate and which pass

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† This lecture was an experimental one, and is here given in a somewhat abbreviated form.

* "Osmotische Untersuchungen," Leipzig, 1887.

† Van 't Hoff, "Phil. Mag.," vol. xxvi., 1888, p. 81.

* Wiedemann's "Annalen," vol. xli., 1890, pp. 1–41. E. Warburg, "Galvanische Polarization." F. Tegetmeier, "Ueber die electrolytische Leitung des Glases und Bergkrystalls." Also "Revue Generale des Sciences," 1892, p. 515.

† "Mem. de l'Acad. Royale des Sciences," 1713 (vol. for 1739, p. 306.)

through metals without their being melted," in which he points to the singular rapidity with which mercury will pass through zinc. He shows that a bar of zinc, one inch wide and half inch thick, will be penetrated by mercury in thirty seconds, so that it breaks readily, although before the addition of the mercury the bar would bend double without any sign of fracture. Guthrie,* who does not appear to have been aware of Homberg's experiment, placed an amalgam of potassium and mercury, containing 1·34 per cent. of potassium, in a hollow cylinder of cast zinc, the walls of which were two millimeters thick and the thickness of the bottom ten millimeters. The amalgam was scraped upon the zinc so as to insure contact, and then covered with petroleum. The zinc cylinder was corked up and covered wth paraffin. It was placed in a beaker of distilled water, and after two months' standing, no potassium found its way through the zinc. Neither could mercury be detected in portions of zinc taken from the outside of the cylinder, though if the mercury had not contained potassium the zinc would have been completely disintegrated, or, as it were, "slaked" by mercury. Not only, therefore, did the potassium fail to follow the mercury into the zinc, but it prevented the mercury from entering the zinc at all. These experiments are of great interest and must be continued, with a view to ascertain the influence of the atomic volume of the metal added to mercury in preventing its penetration of zinc and other metals. It must be remembered that in the case of gold, sodium amalgam "wets" the precious metal more readily than pure mercury does.

*(To be continued.)*

* "Phil. Mag.," vol. xvi., 1883, p. 321.

## DRAUGHT DOGS.

IT is a very curious spectacle to a stranger, to a Parisian especially, who visits Brussels, and particularly Liege, for the first time, to see in the morning innumerable small vehicles loaded with fruit and vegetables arriving at the market drawn by dogs, whose good-natured barking proves not only that they experience no fatigue, but, on the contrary, a genuine enjoyment. It is not only the kitchen gardeners and the peasants coming to the city that make use of this sort of haulage, for the butchers, the bakers, the coal dealers and the milkmen have no other means of carriage in order to serve their customers. Fig. 1, which is a reproduction of a snap-shot photograph, shows a milk woman and her dog cart.

As a general thing, each cart is drawn by but one dog, but there may be several. Thus, in a beautiful picture by Hermann Leon representing a relay of dogs, and that figured at the *Salon* three years ago, the team consists of five animals.

The dog thus employed at Brussels and in its vicinity for the traction of small vehicles is a strong and broad-backed mastiff, more squat than a large Dane or a German mastiff, generally of a dull fawn color or more or less black spotted with white, and with a somewhat short-haired and rough coat. However, the Brabant peasants do not appear to stick to one type of breed with fixed conformation, color and length of hair; provided he is strong and energetic, that is all that they require of their steed with claws and fangs.

Good specimens are sold at from $20 to $25. In the course of service these dogs are fed upon bread and horse meat, and their maintenance costs about a cent a day. The dead weight that they haul is, on an average, 650 pounds. Bulldogs haul a much greater weight.

These dogs are very zealous, and perform their duty with as much pleasure as hunting dogs do in following the trail of game.

An exercise which well exhibits their qualities, and shows the degree of emulation with which they are endowed, is that of the races that frequently take place as a consequence of challenges made by their owners. The racecourse is a highway and the goal is at a distance of one or two miles. All passers-by can enjoy the spectacle *gratis pro Deo*. The competitors place themselves in line, and the impatience of the coursers, which is manifested by voice and action, can be moderated only by vigorous applications of the whip. Finally, the signal is given and they start off at full speed with loud barkings. Falls are frequent, and the drivers often literally bite the dust; but the automatons in short blouse are quickly picked up and put back in their carts, exciting anew their vigorous steeds, and those that have the oftenest fallen are not for that reason the last to reach the goal.

The swiftness of a team of dogs is such that bets on speed have been made on a good horse harnessed to a cab against one of these teams and been won by the latter.

The Belgians say that a good draught dog costs less to keep and sells at a lower price than an ordinary ass, while at the same time often doing as much work. It is quite curious to find that, among civilized countries, Belgium is about the only one that exhibits to us the common spectacle of dogs in harness. Why is it repugnant to people in other countries? In reality (as says our friend Frechon *apropos* of a story that we shall mention further along), is the fact of putting a strong and vigorous animal, sufficiently fed and trained, in the thills of a small vehicle, and of imposing upon him a tractive stress proportional to his muscular power, so shocking in itself? Is it of a nature to give a disagreeable impression to the most sensitive of the members of the Society for the Prevention of Cruelty to Animals? Why does a dog, properly harnessed to a small vehicle adapted to his size, shock us more than an ass or a mule working under the same conditions?

FIG. 1.—DOG CART OF A BRUSSELS MILKWOMAN.

In France the repugnance to harnessing dogs is intensified by the idea that it is forbidden. Now this question of jurisprudence was decided on the occasion of an occurrence to which we alluded above in quoting the words of our friend Frechon on this subject.

Mr. Francis Nantet, a Belgian man of letters, started from Brussels in a cart drawn by two dogs in order to visit the Universal Exposition, and, after seven days' travel, reached Paris. Mr. Nantet met with some obstacles that retarded his arrival, notably an incident that occurred on his passage at Louvroil (North). In this locality the mayor, relying upon the Grammont law, refused to allow the excursionist to continue his voyage unless he changed his means of locomotion. The traveler then conceived an original idea. He put his dogs in the cart and hauled them to the limit of the territory of the commune! Having thus got out of the jurisdiction of the mayor of Louvroil, he harnessed his dogs again and pursued his journey, taking care to steer clear of cities as much as possible. From Compiegne the excursionist telegraphed to his friends in Paris, who went in large numbers to await him upon the road at the moment indicated by him for his arrival. He effected his return by the same means.

The question of law raised by this original voyage had been settled this same year, 1889, on the 19th of January, by the court of appeals in a decision rendered under the following circumstances: A woman, Eugenie L——, had harnessed a dog to a small cart, weighing with its contents 130 pounds, and had made him travel seven miles going and coming. The dog had not been maltreated, had rested several times and had reached the end of his trip without apparent fatigue.

An official report had been drawn up, and the police court of Chateau-Thierry, impressed with the affair, concluded on a simple offense by its judgment of the 10th of November, 1888. The question having been carried to the court of appeals, the latter, on the 19th of January, 1889, rendered the following decision:

"The court, upon the plea drawn from the violation of the law of July 2, 1850, relative to the ill-treatment bestowed upon domestic animals, considering that Eugenie L—— has been prosecuted for having, on the 3d of November, 1888, caused a dog of medium size to draw a two-wheeled vehicle weighing, with its load, 130 pounds, for a distance of about seven miles going and coming, that the sole article of the law of July 2 1850, punishes only ill-treatment practiced publicly and abusively upon domestic animals, that the sole fact of harnessing a dog to a vehicle would not of itself, and independent of all other circumstances, constitute an abusive ill-treatment, and that the judgment attacked states that no act of brutality or violence has been set up against the prisoner, for this reason overrules," etc.

Thus one can harness dogs in France and no one has any right to find fault with it, if the animals are not treated brutally. How unfortunate would the population of the Arctic regions, already so wretched, be without the dog! It is to them, indeed, that might be applied the adage of the ancient Aryans: "Man subsists only through the dog." In fact, it is their sole domestic animal. It takes the place with them of the horse and ox.

The dogs of Greenland, Siberia and Kamtchatka all belong to the same variety. They are from 20 to 24 inches in height and have a pointed nose, straight ears and long and thick hair (which is usually yellowish white), and scarcely differ from the wolf, except in their tail, which is curled upward instead of being pendent. The Eskimo dog is the type of them. We give an exact figure of one of them (Fig. 3) from a photograph. The Labrador dog is of the same group, but is generally of a dark fawn color.

It is harnessed to sleds called *sleigs* or *kometiks* (according to the locality) that dogs are employed in the Arctic regions (Fig. 2). Their harness consists of a simple leather band or breast collar, to which are attached simple ropes by way of traces. No bit, and, consequently, no reins, the voice of the master directing the coursers and his whip urging them on. The Eskimo traveler takes care to place at the head of the team an intelligent and faithful animal, which is charged with the duty of leading all the others. From 10 to 15 dogs, says Benedict Revoil, harnessed together and led by a "captain dog," make from 18 to 24 miles a day in draw-

FIG. 2.—TEAM OF ESKIMO DOGS.

FIG. 3.—THE ESKIMO DOG.

ing a weight from 650 to 1,650 pounds over spaces covered with compact snow or over frozen rivers. After the snow has disappeared, the dogs are set at liberty and provide for their own subsistence. On the approach of the hoar frosts, they return of their own accord to resume their collar of misery. Their sense of smell is very acute and permits them to follow trails even in the midst of snowstorms and to carry the traveler to the hospitable roof toward which he is proceeding.

Mr. Victor Meunier, in one of his *Causeries Scientifiques*, describes a very curious means (if it is true, and the author has not allowed a braggart traveler to tell the tale) employed by the inhabitants of Labrador for exciting their dogs to run with greater speed: "Every inhabitant of Labrador keeps from ten to twelve dogs, which are his steeds, the only ones that he can have, and they serve him only during the winter. Six or eight are harnessed to a small sled in which the master places himself. The whip cracks and the team starts off like an arrow, and twenty leagues are traversed in the space of six hours. Now the following, according to a traveler, is the ingenious and insidious manner in which such continued rapidity is obtained.

"On the eve of the start, all the dogs are submitted to a rigorous fast, an empty stomach having good legs in the dog. I have said all, but it is necessary to except one, and that is the best runner, which the master takes ostensibly into his house and covers with caresses under the nose of its companions. So marked a preference fills the latter with a fierce grief that they promise themselves to make the favorite pay dearly for when occasion presents itself.

"This offers itself the next day when, harnessed to the sled, the jealous dogs see the privileged animal at their head. Scarcely is he in harness before the rest spring forward to devour him. It is for him to run and for them to follow, carrying along with the sled, which scarcely grazes the snow, the man, satisfied with the success of his ruse. It is thus that one works upon the passion of those poor animals . . . exactly like that of men."

Brehm gives other reasons, that are more probable, for the ardor of Eskimo dogs when they are harnessed.

"It is only by means of their dogs that the Eskimos are able, for their subsistence, to derive advantage from the feeble resources presented by the dreary country that they inhabit. During the short duration of summer they hunt the wild reindeer, whose flesh serves them as food and whose skin furnishes the best part of their clothing. In winter, when hunger, drawing them from their miserable huts, obliges them to go in quest of new provisions, they follow the seal into the retreats that this animal forms under the ice, or attack the bear that roams along the coast. Now all such resources would be denied them were it not for the courage and sagacity of their dogs. These animals perceive the hole of a seal at a distance of an eighth of a league and scent a reindeer or a bear at almost as great a distance. The eagerness that they possess for attacking the latter is such that, when they are harnessed to a sled, it suffices to utter the word *neuvrouk*, which is the Eskimo for bear, in order to cause the whole pack to start off at a full gallop. Moreover, such eagerness, in connection with the hunger by which they are continually pressed in winter, renders them difficult to control, so that if, in the course of their route, they scent a reindeer, bear, or seal, it is almost impossible to prevent them from running to make an attack."

The dogs are harnessed to the sled, continues Mr. Gerbe, Brehm's translator, from whom we borrow what follows, by means of a gear quite similar to the straps used by the water carriers and porters at Paris for drawing their little wagon. It is a collar formed of two bands of reindeer or seal leather that pass around the neck, over the breast and between the forelegs, and then unite upon the shoulders, where they are attached to a strong strap whose other extremity is fixed to the sled.

When a team is formed, the most important point is to select a good leader. For this, no attention is paid to the height, age, or sex. What is looked for is that the dog shall be intelligent and have a good nose. When to these two qualities, which are the main ones, is added great strength, the animal is priceless. The other dogs are arranged according to the same principle, that is to say, they are placed so much further to the front in proportion as they have more intelligence and a better sense of smell. The most incompetent is placed at 10 feet only from the extremity of the sled. The leader is 20 feet from it and at about 2 feet from the rest of the team. As for the others, they are not arranged exactly in line; there are always several that draw abreast.

The driver of the sled is seated in front, leg here and leg there, his feet almost touching the snow. In his hand he carries a whip, 20 feet in length, inclusive of the handle, which is about 20 inches in length and made of wood or whalebone. It is only through long practice that it is possible to learn how to use such a whip; but the Eskimos are accustomed to the handling of it from childhood, and, with them, this forms an essential part of their education. Moreover, in driving their sled they avoid the use of it as much possible, and employ it only for correcting some dog individually, for it frequently causes trouble in the team. In order to make the dogs quicken their pace or to make them turn to the right or the left, the voice suffices. For this the Eskimos, like our carmen, have certain words that the dogs understand very well. The leader in particular is very attentive to them and hardly ever fails to obey, especially if, before giving the order, care is taken to call him by name. In this case, he is observed to turn his head over his shoulder, without, however, slackening his pace, as if to show that he has understood.—*P. Megnin, in La Nature.*

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THE first discoverer of the diamond is said to have been a Hindoo named Hakim Fez. Certain it is that the diamond first began to be valued in Hindoostan. For centuries the mines of Golconda were the only ones known, but in 1727 the diamond mines of Brazil were discovered, and in 1868 the famous South African diamond mines were opened up for the first time.

[FROM THE GARDENERS' MAGAZINE.]

## JOHN MILTON'S COTTAGE—A BUCKINGHAMSHIRE VILLAGE.

By J. T. YOUNG, F.G.S.

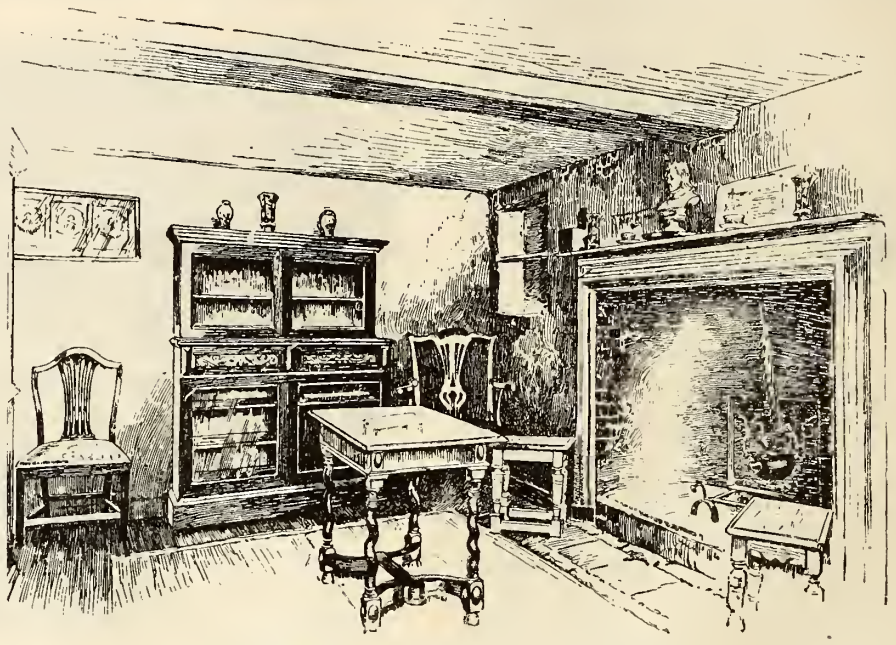
### CHALFONT ST. GILES AND JORDANS.

CHALFONT ST. GILES is only a small village in Buckinghamshire with a little over a thousand inhabitants—none of them known to fame; but to millions of the English-speaking race, on both sides of the Atlantic Ocean, it is a sacred spot. A cottage in the village itself and a small burial ground two miles distant are the points of attraction; the one was for a time the residence of John Milton, the other is the last resting place of William Penn, the founder, rather more than two hundred years ago, of Pennsylvania. Chalfont St. Giles is, however, worth a visit on its own account, and it is more quickly and easily reached now than it was in the seventeenth century, or even a few years ago. By road it is between twenty-two and twenty-three miles distant from Hyde Park corner, the best route being along the Uxbridge Road through Ealing, Hanwell, Southall, and Uxbridge, until the eighteenth milestone is reached, when the traveler turns up the Amersham Road on his right hand, along which he must continue his journey for another four miles and a half before he arrives at his destination. He will not, however, think of going by road unless he be an ardent cyclist, and then the road will probably have greater attractions than the rail. The railway journey, nevertheless, has its conveniences and attractions. From Baker Street to Chalfont Road Station the journey occupies a little less than an hour, but the traveler may, if he prefers doing so, get out at Chorley Wood, the next station this side of Chalfont Road. In either case he will have about three miles to walk, and of the two the walk from Chalfont Road is perhaps the more enjoyable on a summer's day, though it is a trifle the longer. It is one of the special charms of Buckinghamshire and Berks that the scenery is so varied in its details that it reveals fresh features at every turn. Milton's "L'Allegro" accurately describes the feeling of every visitor who comes fresh from city life. He marks "the hedgerow elms and hillocks green," "the plowman near at hand," whistling o'er his "furrowed land," the mower whetting his scythe, or the shepherd "telling his tale" (counting his flock) and the "milkmaid singing blithe," and all the other scenes and features of rural life, according to the season of the year or the time of the day; but in no part of England that we are acquainted with are the words of the poet,

Straight mine eye hath caught *new* pleasure,

more aptly suggestive.

The beech trees which abound in Bucks are one of the attractive features of the county—everybody knows Burnham Beeches, or ought to know them—and was it not long ago settled by authority that the name was derived from the Saxon word "Bucken," a beech tree? Other derivations, it is true, have been suggested, and it has been significantly remarked that the name of the county is, no doubt, derived from that of its chief town, and that there are no beech trees, at least not many of them, in the neighborhood of the town of Buckingham. For our own part, and as no one really knows, we prefer the old and most poetical theory, only if any reader should desire to have an alternative he may take the Saxon "Buccen" (deer), and remembering that King John is said to have had a hunting lodge close by Chalfont, the suggested derivation is not very farfetched. There is, besides, a third plausible theory, that Buckingham was at first "Bock-ing" (a charter meadow) with the common Saxon suffix "ham," indicating a mansion or "vil."



INTERIOR OF MILTON'S COTTAGE.

The three miles' walk from the station brings the visitor into the Amersham Road, opposite the Pheasant, a solitary wayside inn, where he may, if he wishes, generally obtain fairly good accommodation. By the side of this house a road descends directly into the village, which is built on either side of a street, which, if followed, leads to Beaconsfield, about three miles distant. There is a small pond on the green at the entrance of the village; a few shops of the type ordinarily found in small country places represent the trading element of the community, and what seems an unnecessary number of beershops and inns is one of the first features likely to attract attention. There is not, however, any superfluous accommodation for visitors, now that the place is more frequented if not better known than it was when the nearest railway station was seven miles distant. The writer visited it twice in August last, and found each time that its resources were overtaxed, and that visitors who had come to spend the Saturday and Sunday at Chalfont were obliged to seek accommodation at Amersham. The old church of St. Giles is half hidden by the houses on the south side, and is approached through an old lych-gate by the side of one of the half-timbered build-

JOHN MILTON'S COTTAGE.

ings still left. The village is evidently brightening up under modern conditions, for there are not only new buildings in the course of erection in the neighborhood, but there are signs of modern growth and of new ideas in the village itself. The old school, founded and endowed by Sir Hugh Palliser, has been removed to new quarters, and the school room in the center of the village, before which, by the way, a magnificent old elm stands, has been turned into a reading room.

At what was one time the further end of the village stands Milton's cottage. It is the only one of the numerous residences of the poet which remains—the rest have disappeared. We give two views of it—one as it now appears and the other from an engraving dated 1795. Comparing them, it will be seen that besides the addition of an inclosed garden, there have been some structural alterations. The older engraving shows a porch in front of the building, which is absent in the second; it had fallen into a ruinous condition and was cleared away a number of years ago instead of being restored. A small wash house or kitchen has also been added at the farther end, and the house itself has been divided into two tenements, the front part—consisting of two rooms on the ground floor and two above used as bedrooms—being shown as Milton's cottage. Here the poet may have put the finishing touches to his "Paradise Lost;" here certainly he meditated his "Paradise Regained," and almost as certainly wrote part if not the whole of it. Milton, the cottage, "Paradise Lost" and "Paradise Regained" become associated with the burial ground at Jordans through Thomas Ellwood, the Quaker, who was interred there. Ellwood had been introduced several years before to Milton as a young man who would gladly read to him for the advantage of receiving in return some instruction, in Latin especially. Milton accepted his services and they grew friendly through the young man's frequent visits. In 1665 the plague broke out, and spread so alarmingly that all who could leave London were glad to do so. At Milton's request, young Ellwood, then in South Bucks, rented this residence, "a pretty box" he called it, for his friend, and some time in the month of July, Milton with his wife and three daughters took possession of it. Those were troublous times for Quakers. Before Milton arrived at Chalfont St. Giles, Ellwood was in prison, and it was not until a month or so later that he was able to pay the poet a visit. When he did so, Milton lent him the manuscript of the "Paradise Lost" to read, and on his subsequently returning it, Ellwood expressed his admiration of the poem, adding however, "Thou hast said much here of 'Paradise Lost,' but what hast thou to say of 'Paradise Found'? He made no answer," says Ellwood, who tells the story in his autobiography, "but sat some time in a muse; then broke off that discourse, and fell upon another subject. After the sickness was over, and the city well cleansed and become safely habitable again, he returned thither; and when afterward I went to wait on him there (which I seldom failed of doing, whenever my occasions drew me to London) he showed me his second poem, called 'Paradise Regained;' and in a pleasant tone said to me, 'This is owing to you; for you put it into my head by the question you put to me at Chalfont, which before I had not thought of.'" "Milton's room," in which we may imagine the conversation to have taken place, is indicated by the farthest window in the engraving. Not much of the original furniture remains—two stools and a small table are exhibited as such, and appear to be genuine. The quaint open fireplace is unaltered, and the window with its diamond panes is pretty much as it then was. On the walls are some portraits and pseudo-portraits of the poet; a glass case with a few books in it stands under the window. There is among them a copy of the first edition of "Paradise Regained," two volumes which are said to have formed part of Milton's library, one with his initials on the title page, and some other things of no special note. Against the wall is a small bundle of pikes, which used to be preserved in the church, and several small cannon balls dug up in the neighborhood are also exhibited as mementoes of the civil wars. At the farther end of the room is a book case of later date containing a few books. The room on the opposite side of the doorway is much larger, and is used as a living room. The house before it was divided contained four sitting rooms and five bedrooms—some of these latter small enough to be more accurately described as closets. The garden contains some very nice fruit trees, and a plum tree has been trained over the front. The flowers are all common garden varieties—sunflowers, dahlias, lavenders, etc.*

Leaving the cottage and following the main road, which begins at this point to ascend, we pass first the Congregational chapel, and a little afterward the Primitive Methodist chapel; and some cottages which generally appear to have had a modern origin, then past a fine orchard, and presently by some half-timbered buildings which, with the cottages close by, form the hamlet of Households; the most remarkable feature being the ruinous condition of the old buildings, which sadly need repair. A little beyond, a sign post points the way to Jordans, down the road on the left hand. The visitor will need no further guide—he will walk along the charming country road for between a mile and a mile and a half, possibly without seeing a single soul, but if he be a lover of nature, he will not feel the want of society, and may be none the less in a fitting frame of mind to appreciate Jordans when he reaches it. It is simply an old-fashioned plain brick meeting house, lying a little off the roadside on the left hand, and in front of it a burying ground, recognizable as such because of a few grave mounds and several small headstones. At first sight the visitor marvels there should have been so few interments—apparently something between twenty and thirty, and of these the larger number lying near together. Supposing, however, he allows his eye to become a little more familiar with the ground, he will see signs of graves all over it—though the original mounds are in most cases nearly obliterated, and those which stand out so conspicuously do so because they have been restored. Altogether there have been 332 interments since the acquisition of the ground, and the erection of the meeting house in the reign of James II. Among the restored graves is that of Thomas Ellwood, who died in 1713, and that of a much greater man, William Penn, who was interred here in the summer of 1718.

So much of Penn's story as concerns us just now is soon told. He belonged to an old family, and was the son of an English admiral. He was partly educated at Oxford, but was expelled from the university because, under the influence of a Quaker preacher, he refused to wear the college cap and gown; then he was sent by his father to France, where he continued his studies for two years, was presented at the French court, and returned to England, and was introduced to court life here. The crisis of his religious experience was in the plague year, 1665; for while Milton was at Chalfont, Penn was in Cork, where he came once more under the spell of the Quaker preacher, Thomas Loe. How he threw in his lot with the despised Friends; how he was imprisoned on a charge of blasphemy; how in time he became reconciled to his father, old Admiral Penn, who had turned him out of doors when he became Quaker; how Penn married Gulielma Springett, whose remains now lie in the Jordans burying place; how, in spite of his Quaker principles and notwithstanding that he would not remove his hat even in the presence of royalty, he gained influence at court, and preserved the friendship of James II.; how three out of the five children of Penn, also buried at Jordans, were born to him while he lived at Rickmansworth; how while he resided there he dreamed of a land of liberty and peace, of religious and civil freedom, beyond the Atlantic can only be hinted at here. The realization of his dream was rendered possible by the fact that when Penn's father died, Charles II. owed the admiral £16,000, and was more willing than able to pay. He, therefore, made over a wild tract of forest land in America to William Penn, measuring three hundred miles by one hundred and sixty miles, now indicated on the map as Pennsylvania. There were a good many settlers there already—English, Dutch, and Swedish, and there were the Indians also, who had more territorial rights than Charles, and whose claims were seldom much regarded by early European colonists. How considerate he was of these is a matter of history, and in the Jordans meeting house hangs a copy of the well known picture which represents Penn negotiating the treaty of peace and friendship with the Indians, which was so faithfully kept by both parties. Three and twenty shiploads of emigrants, mostly, if not all, Quakers, arrived during the summer of 1683, and so was Philadelphia, the first settlement of the colony, founded, and if there are but few Quakers now in Buckinghamshire, the old families are still represented by their descendants in the United States, and especially in Pennsylvania, with its five millions of population. For the rest, it will be enough to say that Penn returned to England, and after about ten years went back to Philadelphia, where, we are told, he was honored as a governor and loved as a friend by all around him. In 1701 he came back to this country to defend his rights and those of his fellow colonists. Domestic troubles, fraudulent claims, and consequent financial embarrassment and imprisonment in the Fleet, embittered his life and brought on paralysis, and he spent the last five years in seclusion at Ruscombe, near Twyford. Something of all this comes to one's memory as, standing inside the little burying ground, the eyes rest upon the grave mounds and the small memorial stones with the names of those whose remains lie beneath the grass—Joseph Rule, Isaac Penington, and Mary Penington, then Gulielma Penn, the first wife, and under the next mound William Penn and his second wife. Behind these are stones with other well known names, and among them those of Thomas Ellwood and his wife. The latest interments are those of the late Mr. Masterman, the banker, and his wife, between forty and fifty years ago.

MILTON'S COTTAGE. (From an engraving of 1795.)

Of the meeting house itself there is not much to be said. It is as plain as it well can be, inside and out; the window panes are diamond shaped, and the furniture consists of plain forms with backs to them, and a table. At the end of the meeting room it is divided by wood paneling from the part used as a dwelling for the caretaker and his wife; but portions of this paneling are removable, so as to enlarge the accommodation by opening up the dwelling rooms. There is not, however, much need for this, for there are no services there now excepting once in the year—in the month of June—and then all the available space is wanted, for Friends come from considerable distances to unite in the annual service, and the old-fashioned stable at the back with stall room for twenty horses is all too small. It is not surprising that the people of Pennsylvania should have entertained the wish to remove the remains of William Penn to Philadelphia, and in 1881 Mr. G. L. Harrison was empowered to visit this country to obtain if possible permission to disinter his bones and convey them across the Atlantic—though it would have been strange if the request had been complied with. As might have been expected, the application was refused, and they still remain undisturbed in their original resting place.

From Jordans the visitor may, if he likes, walk to Chalfont St. Peters, a direct road to which runs by the side of the meeting house; or, returning to Chalfont St. Giles, pay a visit to the ancient church, in which he will find nothing more quaint than the old sexton, John Clark, who will show him all that is worth seeing, commencing with the Norman font, at which, he says, "I was baptized in the year 1811." He will have something to say also about the half defaced frescoes on the walls, the tombs of the Fleetwoods, who used to reside at "The Vach," and whose arms are on the front of Milton's cottage; he will point out the tomb of Francis Hare, Bishop of Chichester, who died in 1740, and a recent tablet to John Milton, in memory of his residence in the village. Then, if the visitor cares to walk out with him into the pretty churchyard, he will find that his memory is stored with recollections of many of those who are sleeping their last sleep beneath the green turf. Thence he should go to "The Vach," as the former residence of the Fleetwoods is called. To do this, he will leave the village and walk about a quarter of a mile down the high road in the direction of Amersham, pass through the park gates, and up a long and beautiful avenue of limes. Of the house itself he will only see the front, and the best view of this will be gained from the monument to Captain Cook, erected by Admiral Palliser, who was living at "The Vach" when his friend died. There is not much, however, of special interest in what can be seen of the house from the outside, and what there is arises from the memories it awakens, and the illustration its history affords of that "Mutabilitie," of which Spenser sang so impressively:

Then gin I thinke on that which Nature sayd
Of that same time when no more Change shall be,
But stedfast rest of all things firmly stayd
Upon the pillours of Eternity,
That is contrayr to Mutabilitie,
For all that moveth doth in Change delight.
But thenceforth all shall rest eternally
With Him that is the God of Sabaoth hight;
O that great Sabaoth God, grant me that Sabaoth's sight.

* In 1887 the cottage and grounds were purchased by subscription, and vested in trustees, for preservation and exhibition.

## THE EFFICACY OF STATE FOOD LAWS AND THE DESIRABILITY OF NATIONAL ONES.

WITHIN the last few years, several of the States in the Union have enacted laws designed to suppress or control food adulteration, and in some of the larger cities, local ordinances supplement these statutes. The legislatures that have given this subject any considerable attention have also provided a corps of officials to enforce the laws, and, as a necessary adjunct of the work, have either established chemical departments or have retained chemists whose province it is to determine when the laws have been violated.

If the various laws upon the subject were codified, it would be seen that the larger part of them are so similar as to suggest that they had been obtained from the same source, and such, indeed, is the case, the English food and drug act being the basis upon which they were framed.

New York and Massachusetts were the first States to give the matter attention, and they were followed by Ohio, Wisconsin, Oregon, Iowa, Minnesota and Michigan among the Western States. In several other States bills for food laws have been defeated, but the subject is attracting universal attention, and a movement is now on foot to bring the matter before the present Congress in an endeavor to obtain national legislation, which is desirable from several standpoints.

Before considering the desirability of national laws, it is well to review the efficacy of State enactments, to consider how they are evaded and the result of attempts at enforcement.

Probably no term is more generally misunderstood than the word "adulterated" when applied to food stuffs. The general impression conveyed is that the adulterated article is pernicious, unwholesome, dangerous and unclean, while the reverse is more often the case. A wish to obtain an abnormal profit is the cause of all food adulteration, and the same cause would argue against the use of any ingredient that would render an article unwholesome or unpalatable. There is certainly no market for a food that is nauseating or deleterious; and the first thought of the manufacturer is to avoid offending the taste or injuring the health of the consumer.

Over ninety per cent. of adulterated food is noninjurious to health, and the cases that occasionally arise where danger, however remote, is incurred are generally the results of gross ignorance or pure accident. The popular impression that death lurks within the coffee can or vinegar cask is attributable to sensational articles that have gone the rounds of the press and have originated in the brain of some reporter endeavoring to write up, under a "scare" head, a subject of which he was ignorant or concerning which he had been greatly misinformed. A few months ago a leading newspaper in Cleveland, O., published, under startling headlines, the results of the investigations of an Ohio chemist, and among other instances of depravity mentioned, several samples of vinegar were cited that "contained acetic acid and were over half water." As a matter of fact, the New York law permits 93½ per cent. of water in a cider vinegar and 95½ per cent. in a grain vinegar; acetic acid is the sour constituent of all vinegars and the only ingredient of hygienic value.

These sensational articles of the laity are not the only causes of misapprehension. Many chemists and officials, in reporting the results of their investigations, are betrayed into a warmth of expression that is not always warranted. It is hardly fair to brand a sample that falls a fraction of a per cent. below a State standard as "dastardly," "heinous," etc., and this is exemplified by again referring to vinegar. A sample that contains four per cent. of acetic acid (in grain vinegar) is standard in Wisconsin, but it cannot be sold in New York or Minnesota unless it contains one-half of one per cent. more acid.

The conflict of local laws is well illustrated here, for this sample, which may be sold as pure and standard vinegar in Wisconsin, is defined by legislative enactment as adulterated in the States of New York, Ohio, and Minnesota.

The publicity thus given to a grade or class of goods has often defeated the end the officials are striving to attain, as the consumer, hearing repeated tales of the impurity and bad effect of some class of goods that he habitually uses, and failing to observe the evil wrought in his own case, naturally concludes that the whole

thing is a hoax, and in future pays no attention to these reports. A possible advocate of reform is thereby converted into a non-believer and becomes a scoffer at organized effort to correct existing evils, arguing that he uses the food commonly found upon the market and that his father did before him with no evil results; and he therefore opposes the passage or execution of laws that are designed to protect himself and his progeny.

Another factor that exerts a large influence in curtailing the full benefit of the laws is the inherent antipathy of America toward laws that savor in the least of paternalism. In England, Germany, and France much more stringent laws are held in strict observance, but the people are accustomed to a monarchical form of government, and the restrictions imposed are consequently less irksome.

One of the difficulties encountered in punishing violations of the State laws lies in the construction of several of the statutes that fix an arbitrary standard of purity or strength for certain articles. The sale of goods not conforming to these requirements is made a misdemeanor, a quasi-criminal offense, and the dealer who unwittingly handles them and is detected is placed in the very unpleasant position of defendant in a prosecution of this sort. The Supreme Court of New Hampshire has held that this compulsory maintenance of an arbitrary standard is a valid exercise, by the legislature, of the police power for the prevention of fraud, and the New York law does not make fraudulent intent a necessary ingredient of the offense. Where such rigid construction of the law obtains, as a matter of justice and equity the standard should be a moderate one, based upon actual experience extending over a long interval and considering every phase of the article involved, and not a requirement founded upon a hypothetical standard of purity or strength that conforms with theory rather than the conditions commonly met with.

Undoubtedly a merchant is presumed to have sufficient knowledge to discriminate between genuine and spurious goods, but, on the other hand, it seems equally true that he cannot be expected to differentiate between a vinegar, for instance, that contains four per cent. of acetic acid and one that contains four and one half per cent. The estimation is one that requires a certain degree of skill in chemical manipulation, and beyond a mere guess, the retail merchant must rely upon the statement of the jobber or manufacturer from whom he buys, and who is frequently a resident of an adjoining State, where food laws are unknown or inoperative.

The system of State laws, differing like the inhabitants of ancient Gaul, *inter sese*, is productive of another evil. A grade of goods may be made and sold in Illinois that would not comply with the requirement of the Wisconsin laws, and if it is assumed that the demands of the latter State are reasonable, the goods must be sold to the Illinois consumer or in another State likewise unprotected, and one State is thus compelled to accept, consume and pay for goods that are contraband in another. This would be obviated by a national law.

Under the present system, a dealer in Ohio may purchase goods from a jobber in Indiana, and, should he violate a law in their sale, he has no redress beyond a suit for damages, involving a small amount, and entailing an expensive suit, and the official who prosecuted the retailer would be powerless to impose any restrictions upon the manufacturer, who is beyond his jurisdiction. Many retail dealers, against whom charges are preferred for this reason, enter a plea of guilty and pay a nominal fine, rather than incur the publicity that a contest would involve. The merchant thus fined relies upon the probity of his jobber to reimburse him for his loss, and uses a threat of transference of patronage as a lever to compel restitution. If the entire country were governed by the same law, action could be begun against the party really guilty, and the annoyance and ignominy would be spared him whose only offense was too implicit a trust in his jobber.

In a case of this sort, it is extremely doubtful if any real good has been accomplished, and it is more than probable that the retail dealer becomes inimical and his co-operation is lost—a matter of some moment, for the laws can become successful only through the friendly aid of the retail merchants.

If the retail merchant were to purchase exclusively from manufacturers in his own State, it would be possible to reach the party who is really responsible for the fraud, but this would be using the statute to unfairly influence the commercial relations existing between sister States, and would be unlawful. A national law would remove this fault also.

It has been argued that any law restricting the sale of food is contrary to public policy, and that each individual should have the right to determine for himself what he should eat. This reasoning would be sound if every one had attained sufficient skill to be able to judge the matter; but this is a very remote contingency, and one that need not be taken into consideration. Laws regulating the manufacture and sale of food are as necessary as city ordinances restricting the construction of buildings, and have the same end in view, *i. e.*, the safety of the public.

It has been asserted that the entire matter is one that pertains to the commercial world, and so long as an article is harmless it should be sold for what it will bring, without any legal restrictions. While the larger part of food adulteration is the mere practicing of a fraud in business transactions, and therefore amenable to the laws of commerce and barter and exchange, there is a phase that demonstrates clearly the necessity for legislative restriction, and an example shows this. If one cheesemaker produces a cheese from rich, whole milk and sells it for nine cents per pound, realizing a profit commensurate with his labor and investment, and a competitor produces a cheese made from milk from which he had previously removed all or a portion of the cream, which he converted into butter, the latter would reap a reward to which he was not entitled. It is true that the expert buyer would detect the removal of the fat and pay for the cheese accordingly; but when the cheese was put upon the counter of the retail merchant, the consumer, not possessing the experience and skill, of the wholesale buyer, would pay the same price for either, but in the latter instance he would be deprived of a normal ingredient that is of great value to the food and to which he was justly entitled. Not only is the consumer entitled to protection in his pecuniary dealings, but the scrupulous manufacturer is in vital need of the law to protect his honest industry from the more questionable one.

The work that has been done in the last ten years by State food bureaus has demonstrated the need of laws, and it has also shown the defects of local statutes and the want of national ones. The reports issued by these commissions show progress in the art of detecting adulteration, but what has been achieved in checking it, it is difficult to estimate. Certainly the number of convictions and the amount paid in fines are indications of progress, but frequently the cases are similar to those cited above, where a plea of guilty is made and a fine paid as the least public method of settling the matter.

Many existing laws are mere experiments and have paved the way, by their inadequacy or unfairness, for a law that shall be broad and comprehensive, yet specific enough to be effectual. Any law that may be framed upon this subject must meet with one obstacle that will tend to restrict effectual work, and that is the American jury system. The aversion to paternalism is so strong and the ignorance of the average jury so dense that a conviction is almost an impossibility until such time as the people shall have been thoroughly educated. There are exceptions, where prejudice enters into the case, but a prejudiced jury is manifestly an unfair one. It is comparatively easy to convict a milkman of watering or skimming his milk before a city jury, whose members buy their milk from the wagon, and twelve farmers will probably convict a manufacturer of adulterated goods, but if the conditions are reversed, an acquittal is almost a certainty.

Still another difficulty in accomplishing adequate results under the existing circumstances lies in the fact that when an offense is detected and an action instituted, the State is generally compelled to present its case through the prosecuting or district attorney of the county in which the law was violated.

It matters little how skillful an attorney may be or how well he may be read in the law. Unless he has had some experience in technical cases, he is at a tremendous disadvantage when conducting a case in which a life-long familiarity with the subject is on the side of the defendant. True, the experts and officials are present to testify in behalf of the State, but their knowledge and experience is useless unless it is skillfully brought out, and the attorney, cautiously feeling his way upon *terra incognita* is unable to take advantage of many opportunities that could be fully utilized by a lawyer whose business it was to conduct prosecutions under a national law, and who was thoroughly familiar with the techno-chemical questions involved.

A national law would be of vast benefit in the way of centralizing the work and lessening the expense of maintaining a corps of competent men, and, what is still more important, of improving the present methods of detection of adulteration and of devising new ones. In the chemical examination of foods it is much the same as in the art of war. No sooner is a gun invented that will penetrate any known form of armor, than an impenetrable armor is devised; and no sooner is a chemical method of detecting an adulterant perfected, than some genius produces a substance that is, for a time, comparatively safe from detection.

The chemist of a State food bureau is compelled to examine every article that is submitted, making hundreds of analyses each month; and working yesterday with vinegar, to-day with butter, and to-morrow with cream of tartar, he barely finds the time necessary to make a careful examination of each, and original work is out of the question. If the work were under government supervision, laboratories throughout the country could be fitted up for special work, and one chemist could devote his entire time to one line of food stuffs, and would thus be afforded ample time and opportunity to thoroughly investigate his specialty, and could keep pace with all that is being done.

A legal department would be a very necessary adjunct, and the attorney and his assistants could qualify themselves to conduct cases that require as much technical as legal knowledge.

In framing a bill for Congress, some radical departures from the State codes will be necessary, but the prime feature in any law that may be passed should be to construct a statute that is founded upon reasonable demands, based upon a thorough, practical knowledge of the properties and the process of manufacture of the article affected.

GEORGE S. COX,
State Chemist.

Madison, Wis., Sept., 1893. Wisconsin Dairy and Food Commission.

## VITALITY OF CHOLERA ORGANISMS.

SOME interesting investigations on the vitality of the cholera organisms on tobacco have been made by Wernicke (*Hygien. Rundschau*, 1892, No. 21). Small pieces of linen soaked in cholera broth cultures were rolled up in various kinds of tobacco, and the latter made into cigars. At the end of twenty-four hours only a few bacilli were found on the linen and none on the leaf. On sterile and dry tobacco leaves the bacilli disappeared in one-half to three hours after inoculation. On moist, unsterilized leaves they disappeared in from one to three days, but on moist and sterile leaves in from two to four days. When introduced into a five per cent. tobacco infusion (ten grammes of leaves to two hundred grammes of water), however, they retained their vitality up to thirty-three days; but in a more concentrated infusion (one gramme of leaves to two grammes of water) they succumbed in twenty-four hours. When enveloped in tobacco smoke they were destroyed, both in broth cultures as well as in sterilized and unsterilized saliva, in five minutes. Tassinari, in his paper, "Azione del fumo di tabacco sopra alcuni microrganismi patogeni" (*Annali deli Istituto d' Igiene*, Rome, vol. i., 1891), describes a series of experiments in which he prepares broth cultures of different pathogenic microbes, and conducted through them the smoke from various kinds of tobacco. Out of twenty three separate investigations, in only three were the cholera organisms alive after thirty minutes' exposure to tobacco fumes. But in actual experience the apparent antiseptic properties of tobacco have not unfrequently been met with; thus, during the influenza epidemic in 1889, Visalli (*Gazetta degli Ospedali*, 1889) mentions the remarkable immunity from this disease which characterized the operatives in tobacco manufactories; that in Genoa, for example, out of 1,200 workpeople thus engaged, not one was attacked; while in Rome the number was so insignificant that the works were never stopped, and no precautions were considered necessary.—*Nature*.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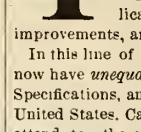

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## THE UNITED STATES WAR SHIP COLUMBIA.

In our SUPPLEMENT 935 we gave a view of this great ship, and we now present another illustration, showing the vessel as photographed when running at high speed on her trial trip. On this occasion, December, 1893, her mean speed was 22·81 knots per hour, thus showing her to be one of the fastest vessels afloat. Our present object is to let our readers know how she appears to the eyes of others, and this is what is said of her by *Engineering*, London. It is from the pen of Mr. William Fairburn. In the Columbia the United States has sought to produce a vessel absolutely without parallel as a commerce destroyer among the war ships of the world. The combination here made unites a sufficient armament with complete protection against light guns, while at the same time the vessel has a sea speed of close on 23 knots, and a coal endurance hitherto unknown in ships of war. She is a match for the swiftest transatlantic liner afloat to-day carrying an armament of which such a vessel is capable, and no merchant vessel that she meets, armed or unarmed, can escape her.

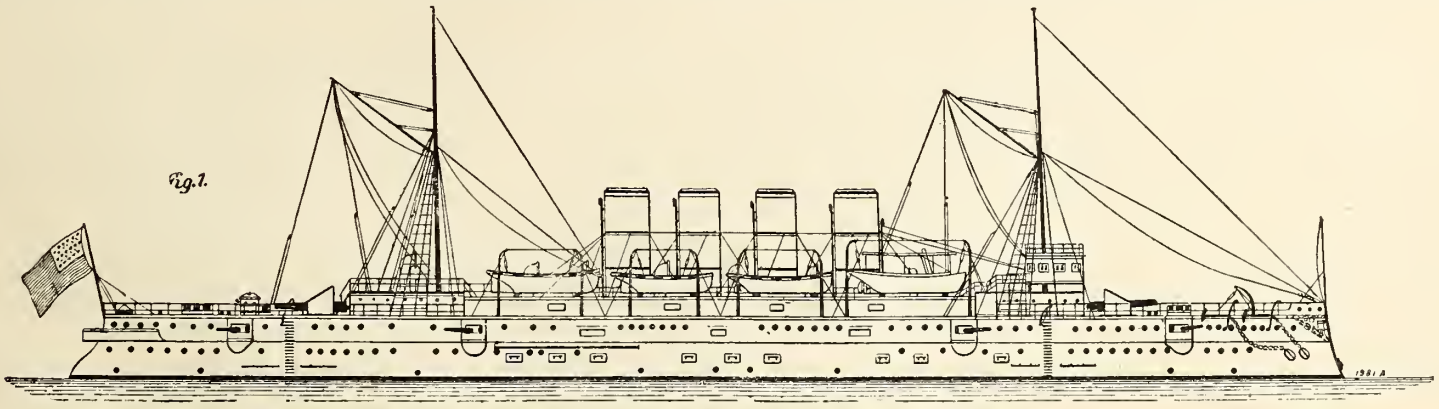


Fig. 1.

The Columbia was lately built at the yard of Messrs. Wm. Cramp & Sons, of Philadelphia, the contract price for hull and machinery being $2,725,000, though the complete cost, including armament and speed premiums, is estimated at $3,600,000, or about £750,000.

The following are her principal dimensions :

| | |
|---|---|
| Length on load line..... | 412 ft. |
| Beam moulded..... .. ..... | 58 ft. |
| Draught; mean normal... ..... | 22 ft. 6½ in. |
| " " load.... ..... | 25 ft. 5¼ in. |
| Normal displacement..... | 7,356 tons. |

She is constructed throughout of steel, a double bottom being worked the length of the machinery and boiler spaces, while forward and aft of this the frames consist of continuous Z-bars, spaced 42 in. apart, the transverse frames in the machinery spaces being 48 in. apart. The vessel has three complete decks, including the armored deck, also a large superstructure or bridge deck amidships, on which are carried the boats, etc. A rounded steel protective deck runs the full length of the vessel. This deck is 4 in. thick on the slopes, and 2½ in. elsewhere ; the top of the deck beams at sides being 4 ft. 6 in. below the load line, and the beams at center generally 1 ft. above, except at the ends, where the deck tapers down to the side line of the beams. The flat or crown of the deck is worked in two thicknesses of 1¼ inch steel plates; on the slopes over the machinery and boiler spaces an additional thickness of 1½ in. is worked on top of the 1¼ in plates, making the total thickness on slopes 4 in. A cofferdam 60 in. in width is worked between the protective and berth decks at the water line region, and extends completely around the ship, the space in the central portion being filled with patent fuel, capable of use in an emergency, and forward and abaft with water-excluding substance, such as cellulose. An additional safeguard against the effects of damage near the water line is formed by the storage of coal on the armored deck.

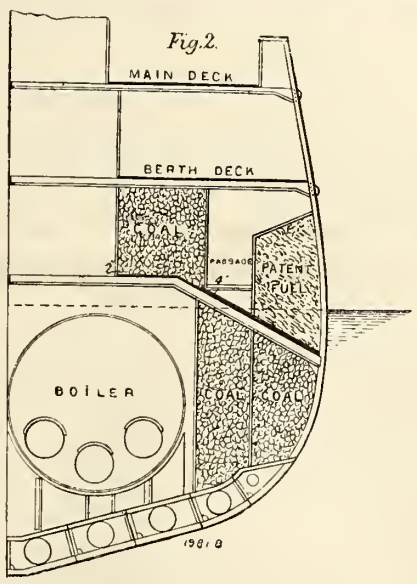
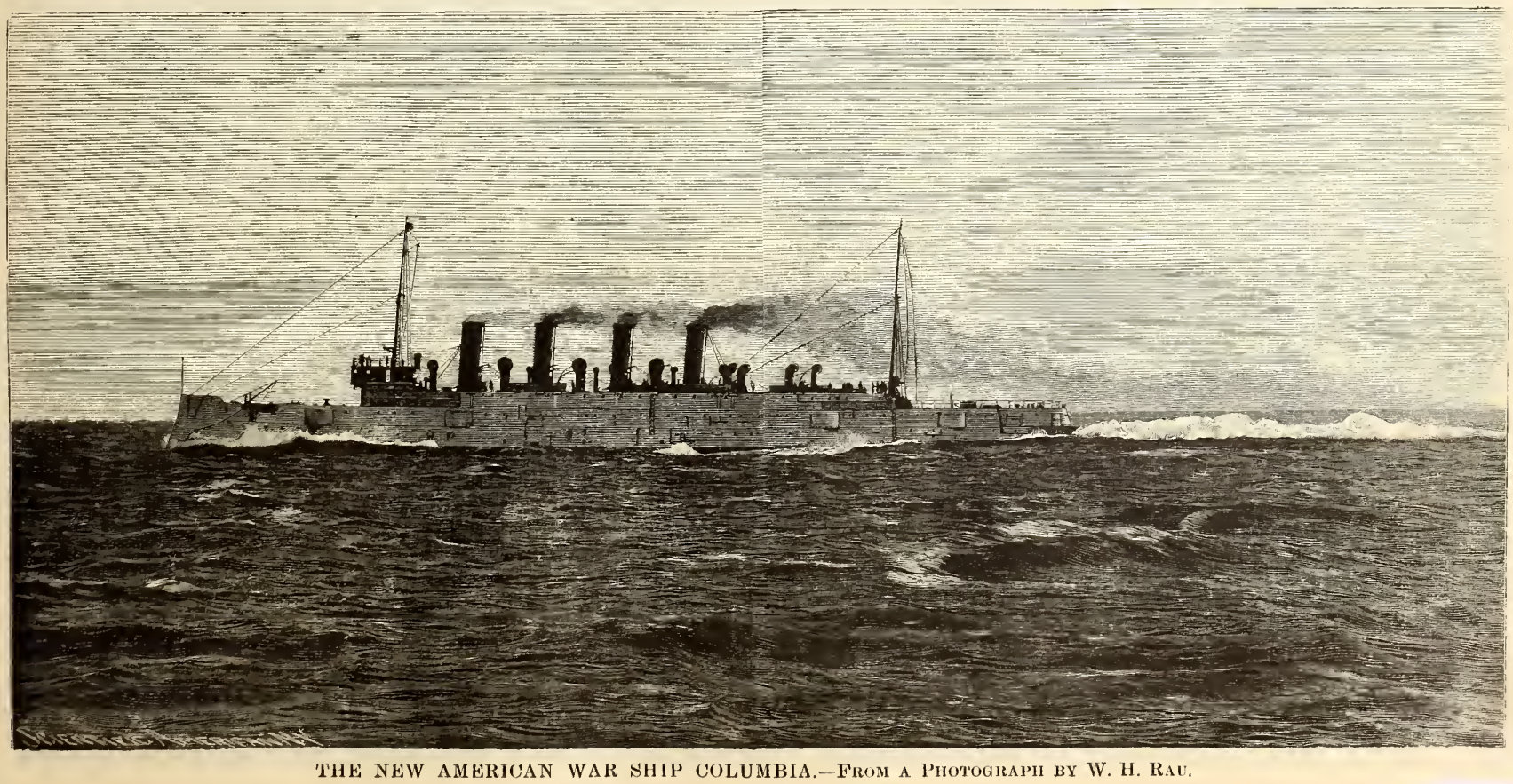



Fig. 2.

The main battery of the Columbia consists of one 8 in. and two 6 in. breechloading rifles, and eight 4 in. rapid firing guns, while the secondary battery is made up of twelve 6-pounder and four 1-pounder rapid firing Hotchkiss rifles, four Gatling guns, and six 15 in. torpedo discharge tubes, two of which are submerged. The total weight of the vessel's all-round fire is 790 lb., of which 402 lb. can be fired directly ahead, 356 lb. astern, and 520 lb. on either beam. In wake of the 4 in and machine guns, the ship's sides are protected with 4 in. and 2 in. steel plates. The two 6 in. guns are mounted on the main deck aft, and the 8 in. gun forward in the open, and all three are well protected by heavy steel shields attached to the gun carriages. The vessel's freeboard to the main deck is 20 ft., and this, together with her great length, will enable her to fight her guns and maintain her speed in a sea that would render smaller ships practically useless. The full complement of the Columbia consists of about 500 men, and both the officers and crew are accommodated on the upper and lower berth decks, the former being generally called the gun deck. The officers' accommodation consists of handsomely fitted cabins situated aft, the superiors being located on the upper deck. The vessel is fitted as a flagship, the admiral's quarters being at the extreme aft end of the upper berth or gun deck, and in



THE NEW AMERICAN WAR SHIP COLUMBIA.—From a Photograph by W. H. Rau.

direct communication with a handsome stern walk. The crew's accommodation forward is much superior to that ordinarily found on modern high speed war ships, and their quarters are spacious, comfortable, well lighted and ventilated.

The arrangement of the Columbia's motive power is somewhat novel, as the force is transmitted through three screws, one placed amidships as in ordinary single-screw vessels, and two others placed farther forward, one on each side, as is usual in twin-screw vessels. This arrangement in war vessels is not entirely new, having been adopted by the French in some of their high speed modern ships, and more recently by the Germans in their Kaiserin Augusta, but it represents the latest advance in the steam engineering line where such great power is to be transmitted. If twin screws were used, 11,000 indicated horse power would pass through one shaft; now each shaft transmits only 7,300 indicated horse power, and the vessel has one more chance in case of breakdown. Referring to the triple screws fitted on the Columbia, Mr. George W. Melville, the Chief of the United States Bureau of Steam Engineering, of the Navy Department, says:

"Knowing that it was extremely improbable that shafts of the great size necessary to transmit this enormous power to twin screws could be obtained in this country, either in reasonable time or with any guarantee as to strength, the bureau decided to depart from the usual practice, and to divide the power into three parts instead of two, each being developed by a separate engine driving its own screw. It was still further influenced to do this by the knowledge that even in case of the recurrence of so remarkable an accident as that which lately happened to the City of Paris, this cruiser would still have a reserve of power sufficient to drive her at a good rate of speed. Indeed, it is almost impossible to conceive a combination of circumstances or accidents that would render her entirely helpless."

The machinery consists of three independent sets of vertical inverted direct-acting triple-expansion engines, the cylinders having a diameter of 42 in., 59 in., and 92 in. respectively, with a common piston stroke of 42 in. The main valves are of the piston type, there being one double-ported valve for each high-pressure cylinder, two single-ported ones for each intermediate, and four single-ported ones for each low-pressure cylinder. The valves for the high-pressure cylinder are not packed, while those for the intermediate and low-pressure cylinders are packed in the usual manner with rings. The diameters of the valves are—high pressure, 18 in.; low pressure, 21 in.; intermediate pressure, 23 in. They are driven by Stephenson double bar links fitted with steam reversing gear and hydraulic controlling cylinders. The intermediate and low-pressure cylinders are steam-jacketed, and the high-pressure cylinders provided with a lining, all the liners being made of cast iron as hard as tools can work it.

The cylinders are supported at the back by inverted Y frames, to which the slides are attached; they are supported on the front by cast steel cylindrical columns. The bedplates are of cast steel of I-section, well ribbed. The piston, connecting, and all working rods are of forged steel. The condenser shells are rolled brass ¼ in. in thickness, with cast brass heads containing the various nozzles and openings. The sheets are riveted together and to the heads, and the joints then soldered. They are also fitted with man holes and plates, and facilities for boiling out and cleaning. Each condenser contains 4,904 seamless drawn brass tubes, tinned on both sides, 11 ft. 10 in. long, No. 20 B.W.G. thick, ⅝ in. outside diameter. The tubes are so packed that each may expand freely, but are prevented from crawling. Each condenser has 9,496 square feet of cooling surface, and the interior is so divided by diaphragm plates that the steam is brought into contact with all the parts of it, thus rendering the whole of it efficient.

Condensing water is supplied to each condenser by two circulating pumps, each capable of discharging 6,750 gallons per minute. These pumps are made of composition, with phosphor bronze runner shafts running on lignum-vitæ bearings in the water space. They can also be used as bilge pumps in case of a leak, and are so fitted with valves that communication with the sea and with the bilge cannot be open at the same time, thus preventing flooding the ship by accident. The air pumps are two vertical single-acting lifting pumps for each engine, the pumps being 22 in. in diameter by 20 in. stroke. They are driven by two simple engines, with cylinders 7 in. in diameter and 12 in. stroke, arranged to exhaust into the condenser or into either receiver. The engines are geared to make 2½ complete revolutions for each double stroke of the pump to which they are attached. The propellers are all constructed of manganese bronze, and have been adjusted to the pitch found best on trial. The central screw has four blades, and about 10 per cent. more pitch than the side ones, as it works in more or less disturbed water. The side screws are three-bladed. It may be interesting to note that the side propellers are placed about 15 ft. forward of the center one, thus avoiding as much as possible working the latter in the race of the former. It is also to be understood that, looking at the ship from aft, the propellers are not in the same horizontal line, but that the side ones are placed as high as their diameter will permit; also, that to bring these propellers clear of the ship's sides the side shafts incline outward from the center line of the ship 4 deg., and also slightly upward. The shaft of the center propeller is in the central longitudinal plane of the ship and inclined slightly downward, making the center of this screw 52 in. below that of the side screws.

Steam is supplied by eight main and two auxiliary boilers, all built of mild steel. Six of the main boilers are 15 ft. 6 in. in diameter outside and 21 ft. 3 in. long, and two are 11 ft. 8 in. in diameter and 18 ft. 8 in. long. The shells of the large boilers are 1 1/16 in. thick, those of the smaller ones 1 1/16 in. The two auxiliary boilers are 10 ft. in diameter and 8 ft. 6 in. long, and all are constructed for a working pressure of 160 lb. to the square inch. The main boilers are of the Scotch type, double ended, and with 2¼ in. steel tubes. Each large boiler has eight corrugated steel furnaces of 39 in. internal diameter, and each small one four, with an inside diameter of 42 in. The heating surface of each large boiler is 5,932 square feet, of each small one 2,870 and of each auxiliary 968½, making a total of 43,269 square feet. The total grate surface is 1,285 square feet, each large boiler having 175·5 square feet, each small one 84 square feet, and each auxiliary 32 square feet. The auxiliary boilers are placed above the protective deck, while the main boilers are arranged in groups of two in four separate watertight compartments, with five athwartship fireroons and four large smoke pipes.

The forced draught is on the closed fireroom system, each fireroom being fitted with two large Sturtevant centrifugal fan blowers. Feed water is supplied by a main and auxiliary feed pump in each working fireroom, and an auxiliary feed pump in each engine room.

There are evaporators, distillers, reversing and turning engines, fire and bilge pumps, ice machines, steam ash hoists, steam windlass, capstans and steering gear, and all the other auxiliaries now fitted to modern war vessels.

A feature of the motive power design that carries a strong argument in its favor is that by means of clutch couplings either propeller can be disconnected from its engine and left free to revolve, thus retarding the way of the ship but very slightly when she is being propelled by one or two engines. A still further advantage is that in moderate cruising, say with one-third power, a few boilers can be used with the high steam pressure for which they are intended, and one engine driven at the full power for which it is designed. By this means the power will be obtained economically instead of wastefully, as is the case when a large engine is run at a low power. It has been estimated that with one-third power and one screw the ship can be driven about 15 knots; with two screws and two-thirds power, from 18 to 19 knots, the screws not in use being allowed to revolve freely.

The weight of all the propelling machinery, including auxiliaries, water spaces, etc., is 1,953 tons.

The total coal bunker capacity of the Columbia is 2,080 tons, which, at a cruising speed of 10 knots, will give her an endurance of 105 days and an effective radius of action of about 25,600 knots, therefore she needs neither colliers nor coaling stations, for she carries both between her decks. In other words, this ship, so powerful in offensive force as to equal all ordinary cruisers, so well protected as to be hardly vulnerable to the lighter class of guns, so abundantly supplied with separate engines as to be incapable of being wholly disabled, can steam completely round the world without touching at any point for coal, and without receiving fresh supplies from colliers, and yet when the occasion arises she can overtake with ease the fleetest of the ocean greyhounds.

Speaking of the Columbia's great cruising qualities, Secretary Tracy, of the U. S. Navy Department, says: "A dozen such vessels would, in my opinion, exterminate the commerce of any country under the present conditions of commerce protection, and would thus, under these conditions, absolutely preclude an attack from a commercial state, however threatening in its demands, powerful in its armored fleets, or aggressive in its foreign policy."

## THE JETTIES AT THE MOUTH OF THE MISSISSIPPI RIVER.

*Editor of the Scientific American Supplement:*

Your issue of December 9 contains a letter by E. L. Corthell, President Southwest Pass Improvement Company, replying to "one or two statements" in my article on the Mississippi River published in the SUPPLEMENT of November 11, 1893.

Mr. Corthell tacitly admits the anomalous high water condition at New Orleans as stated in my article, but omits to indicate or explain the cause. Also, a feature of his letter is the absence of facts to support its assertions.

1. Mr. Corthell says: "The almost immediate effect of placing obstructions in the head of South Pass was the deepening of the two large passes on each side, which carry to the sea ninety per cent. of the volume of the main river" by "turning the volume of South Pass."

Which, in fact, proves the initial work to have been a dam. Here the blunder began. It was intended and believed that this initial work would cause a greater volume to flow into and "scour" the South Pass; but unexpectedly the water turned and ran off by the other passes.

2. With regard to the obstructions subsequently placed in the two large passes Mr. Corthell says: "The sills, only two feet thick in a river thirty feet or more in depth, did no more than restore the natural conditions, for Southwest Pass had deepened over two feet and Pass a l'Outre over three feet before the sills were laid. The only object of these sills was to restore to South Pass the volume of which it had been depleted by the dikes that had been built in the head of the little pass."

This neatly describes the damming process. These sills and dikes had the direct effect to raise the head of water in the river and cause its refluence up stream. Common experience will confirm this effect. But to evade this natural conclusion concerning the action upon the volume of the river, he claims that the sills only restored the normal flow to the passes. As well could the miller, ignoring his dam and pond, claim that the normal volume of the stream ran over his weir. The writer of the letter should logically demonstrate how it were possible for "obstructions" in the South Pass which turned the flow of the Mississippi, followed by other "obstructions" in the two large passes causing refluence of the volume, could act otherwise than back up the water in the river. Even the small boy practically understands damming by "sill" when he places a stick upon the bed of a meadow brook to make a pool above in which to catch minnows.

With regard to the height and character of these sills, I prefer Captain Eads' testimony that in places the "sills were raised five feet;" of others "which brought it above the water;" and that, "where these dams were built in water 18 feet deep, after one season of flood we found it difficult in getting a yawl boat near to them."

It became absolutely necessary to impose upon South Pass a greatly increased volume. The works were extended and enlarged. The "two feet thick" sills were overtopped. Dikes, wing dams, sills, spur dikes, piers and other devices were employed. The works proved so effective that the two large passes, which before had carried all the commerce, shoaled and were lost to navigation. In consequence these main channels, which before had discharged ninety per cent. of the volume of the Mississippi River, were dammed.

These facts concisely represent the actual situation at the mouths of the Misissippi.

3. Mr. Corthell says: "I can assert that no results whatever in raising the river one inch at New Orleans have ever proceeded from any of the works at any time placed in the passes of the Mississippi River."

Considered in relation to the unquestioned data in my article, showing the conduct of the river at New Orleans in the rise of 1892 and 1893, this assertion will collapse.

President Dreyfous, in his recent annual message to the New Orleans levee board, states: "It is noteworthy that the stage of water has grown higher yearly since 1890."

It is known that no great rise from the Ohio River occurred in these years: that Red River, by means of government works, discharged its flood volume down the Atchafalaya: that no natural condition obtained to cause this higher yearly stage; also, it is known that artificial works have been constructed which reduce the effective area of discharge and consequently raise the flood surface; therefore the conclusion is reasonable and must stand until overset by superior proof—that this condition of higher yearly stage at New Orleans is caused by the jetty system, of which the works in the mouths of the Mississippi are most pronounced and obstructive in their effect.

This higher stage last year at New Orleans exceeded by one and nine-tenths feet the high water of the great flood of 1884. An inch of water at New Orleans is held to be most significant by river men and scientists. The action of the Mississippi is testimony of the highest character and is to be preferred to the assertion of an interested person. This higher yearly stage concerns New Orleans and the Mississippi Valley.

There is a diurnal tide in the Gulf of Mexico at the mouths of the passes having a mean rise of one and one-half feet. It is known that a maximum or spring tide at the mouth of Southwest Pass previous to the construction of the jetties caused a rise of three-tenths or four inches at New Orleans during high flood period in the Mississippi. The tide is only temporary, occurring once in twenty-four hours. It is practically a water bar of brief duration.

When, therefore, a transient water bar having a height of one and seven-tenths feet at the mouth of Southwest Pass shall cause a rise at New Orleans, still more shall permanent dams in the mouths of the Mississippi of greater height and obstructive character cause a much higher stage of water at New Orleans. The obstruction being permanent, it is obvious that the highest stage will also be continuous, until the Mississippi finds an unobstructed channel to the gulf.

4. Again, Mr. Corthell says: "If the dams had raised the water to any appreciable extent and prevented its free flow to the sea by the three passes, it would have at once sought relief through these crevasses (Cubits and another) and kept them open to their full size, which it did not, or made others immediately, for the bed and banks of the river here are composed of material moved with the greatest ease by any acceleration of the current."

This statement is misleading and erroneous. The Mississippi has made repeated attempts year after year to open a new channel and escape from the obstructions. The resources of the jetty company have been taxed to close these breaks. Witness one instance. An upper dam, 1,675 feet in length, near Pass a l'Outre, constructed in 1879, was attacked three years ago by the river. The government officer reported that 1,163 feet of this dam had been washed away, that "the channel is still increasing, the dam is being rapidly undermined and carried away, and in turn the rapid current encroaches upon the land formation below and it is wearing away rapidly. Another attempt will be made to close Pass a l'Outre crevasse during next low water season, though, in the meantime, if the remaining 512 feet of the upper dam should be carried away, the effect upon South Pass may be serious."

These facts overset the above statement of Mr. Corthell.

Cubits crevasse was originally a dugway made to pass a fisherman's yawl. After the construction of the jetties the boatway rapidly increased in size. It now discharges a larger volume of water than it did at the time of the beginning of the jetties. The two crevasses referred to are open at the present time.

Also, the Mississippi is a bank builder. It is well known that the Mississippi, when flow in its natural channel is unobstructed, closes crevasses and breaks. The history of the Mississippi furnishes abundant proof of this action.

Hence, the fact that Cubits crevasse and another are now open is precise proof of the obstruction and damming.

5. Also, he says: "I am equally confident that the spur dikes placed in the river at and near New Orleans have had no effect upon the flood height."

These dikes are constructions of timber, piles, brush and stones placed in the natural channel or bed of the Mississippi. These dikes occupy some portion of the effective area of discharge of the river. In calculating this area for the section, the scientist would unquestionably exclude the volume of the dike. It is well known that material of this sort upon the bed of the river obstructs the flow and raises the head of water. Hence, these spur dikes are directly implicated in the high water condition at New Orleans, the same relatively as are the sills and dikes in the passes. One illustration of their effect upon the river will be given.

In 1887 there was an extreme and long-continued drought throughout the entire Mississippi Valley. The water in the Mississippi reached a lower stage than for twenty years. At Vicksburg the mean stage for the month of November was four and two-tenths feet below the mean stage for November, 1886. At New Orleans the mean stage for November, 1887 was one-tenth of a foot higher than the mean stage for November, 1886. It is to be recalled that the flow for November in both of these years was remarkably even at both places. Had natural relativity of stage obtained, or had the Mississippi been unobstructed, the stage at New Orleans in November, 1887, would unquestionably have been

one foot to one and a half feet lower than it actually was.

The chief signal officer, after a searching investigation of this stage of water at New Orleans, of the integrity of the gauge and of related conditions, reported: "There is shown to be a relatively high stage at New Orleans. The cause of this may be due to the fact that there is a gradual obstruction to flow, owing to an accumulation of some sort in the vicinity of New Orleans."

The cause is found in the artificial works and resultant sedimentary accumulation.

No other solution is possible from the given phenomena.

6. Of the proposed improvement of Southwest Pass Mr. Corthell says: "All that the company which is organized for this purpose desires is that the natural normal volume of this pass be given it. This the pass now has. We intend only to build works in the mouth of this pass in the Gulf of Mexico, and we believe that this is all that is required to give a permanent channel of much greater dimensions in width and depth than it is possible to make in the little pass."

I maintain the Southwest Pass has not its natural normal volume. It has been deprived of its normal volume by the dams and their consequent shoaling of the pass. The well-known fact that the normal volume of South Pass has been greatly increased, is precise proof that the normal volume of the two other passes must have been decreased.

Granted the normal volume for the Southwest Pass, and that the proposed works be built in the mouth of this pass in the Gulf of Mexico, it will not be possible to obtain a permanent channel of the width and depth claimed by Mr. Corthell.

The present action of the Mississippi River is a positive demonstration that the results hoped for by Mr. Corthell will not be obtained by the present incompetent plan.

WILLIAM L. ELSEFFER, C.E.
18 Broadway, New York City, January 8, 1894.

## VEGETABLE PARCHMENT: ITS PROPERTIES, USES, AND MANUFACTURE.

VEGETABLE parchment has been known as a commercial product for very many years. It was first manufactured as a substitute for animal parchment for use in certain branches of industry, as it was found to fulfill all the necessary needs which the real parchment had hitherto supplied. It is besides a much cheaper product, and for many purposes a superior one. A steady and large demand exists for it at the present day, the consumption of it in this country being very large; but, strange as it may appear, only small quantities are produced in England, the larger part of this branch of the paper manufacture being confined to Germany.

The composition of vegetable parchment has been studied by many chemists. According to Girard it is essentially a hydro-cellulose. It is perfectly odorless, and when well made is of uniform texture, resembling in appearance the skin of a bladder. It is translucent and possesses the unique properties of retaining its toughness when thoroughly wetted with water and of regaining its original strength when dried. It is practically grease proof, but although not altogether impervious to water, is known to effectually protect, in a large measure, commercial goods in the wet or dry state from the influence of moist or dry air.

Its uses are very various. As a substitute for animal parchment, with which it is closely allied in reliability and hygroscopic properties, it has been used for many years in the bookbinding trade; and, also, for documents where durability is of paramount importance. It is not attacked by insects like animal parchment, and if properly made is quite as durable. Owing to its strength, durability, and great toughness when saturated with water, it is extensively used for covering vessels containing fruit and other preserves, sirups, etc., and in the preservation of polished brass and iron goods. In the provision trade very large quantities of the thinner kinds are consumed annually for wrapping up butter and other fats.

### THE RAW PAPER.

The raw paper which is to be transformed into parchment must be chemically pure, that is to say free from lime, soda, chlorine, etc., and be as spongy as blotting paper. It must be prepared without the usual sizing (resin soap) or alum. Different raw materials are used for the various strengths of parchment papers, because the method of treatment also varies. When the raw stock is intended for thick parchment, it should be soft and possess great absorbing power; while for medium and thin qualities, it should be harder and stronger, so that it can be parchmentized without fear of the web breaking or tearing.

It is advisable to use cotton rags exclusively for thick papers having a weight of 75 to 150 grammes per square meter. These rags, after bleaching, are manipulated in the same way as for blotting papers. The treatment of the raw stock in the beating engine depends upon the thickness of the desired paper, and must be conducted on well-known lines. If thick papers are being made, the pulp should be finely beaten, but for medium and thin weights the fibers must not be too short. Thick papers should also be made on the machine without the use of pressure, while thin and medium sorts should receive a little pressure, in order to enable them to withstand the parchmentizing process. A small quantity of linen rag stock can be mixed with cotton, in the preparation of the latter kinds, so as to obtain a stronger paper in endless rolls. In certain known kinds of thick parchments the addition of 30 or 50 per cent. of linen rags is necessary, viz., for osmose parchment, used extensively in the manufacture of sugar. Great strength and porosity are desired in this parchment paper, because the sugar sirup has to pass through it, and, as is well known, linen fibers are parchmentized less quickly than cotton fibers. It is, however, necessary to guard against preparing the pulp too hard, as good parchment paper must be parchmentized through and through in order to allow the osmose of the liquid to go on properly and well. When preparing parchment for this purpose it is absolutely necessary to do so from clean stock, *i. e.*, rags free from foreign substances. In no case should it be attempted to make raw paper from anything but well-sorted and clean rags, and to prepare these with water free from sedimentary matter, such as coal dust, sand, etc. The presence of alumina, chlorine, and more especially of particles of lime in such papers, is ruinous, for the obvious reason that the lime forms a compound with the sulphuric acid and produces faults in the parchment, which, although they can only be found by the experienced worker, yet render the whole sheet entirely worthless.

This is likewise the case with other impurities, such as coal dust and sand. Indeed, a high class, properly made paper is the necessary foundation of a good parchment; otherwise the labor of the parchment maker will be lost. There is much to be gained by the different degrees of speed with which the raw paper is passed through the acid bath and by other practical details in the mixing of the acids, etc., but it is difficult to counteract, at this stage of the manufacture, a wrong treatment of the pulp or correct impurities in it.

It is the opinion of many makers that the best parchment papers were made twenty-five years ago or earlier. As at that time no great stress was laid upon their color, the half stuff was allowed to thoroughly drain after bleaching before being reduced in the beater. The stock was then opened up, and made thoroughly absorptive; the raw paper made from it being of excellent quality, was easily and quickly parchmentized. The parchment paper was clear and bright, with a yellowish appearance, and as strong as leather. To-day, however, the demand is for *white* parchment, and if this is to be made, it is necessary to artificially color or highly bleach the pulp. By coloring, the fibers are simply veiled, while by bleaching them to a high degree of whiteness pulp is not only lost but it is hardened, the pores of the individual fibers being partly filled up. The acid mixture used in the manufacture has, accordingly, no such unlimited power over the fibers as was formerly the case, for they were then chemically pure, open, and loose. In order, therefore, to make good parchment paper, the raw stuff should be made so that the acid can thoroughly penetrate into the fibers and unite them together.

It is absolutely necessary to pay great attention to the purity of the acid, otherwise it will not parchmentize well. If it, or indeed any of the raw materials, contains dirt, such as sand or particles of coal dust, the final production will get damaged in the course of manufacture. Washing with pure water in the beater and elsewhere will aid the practical man a great deal in obtaining a perfect sheet of parchment. Every precaution should, therefore, be exercised in the sorting and boiling of the rags, and particularly in getting rid of any undissolved particles of lime or soda lye by subsequent washing with pure, clean water.

### THE SELECTION OF THE RAW MATERIAL.

For some years cellulose has been mixed with cotton rags in considerable quantities for the manufacture of the raw paper in the preparation of the thinner kinds of parchments; for weights varying from 30 to 45 grammes per square meter. Soda and sulphite cellulose are equally applicable for this purpose, especially in the bleached state. Such materials possess the desirable property of great toughness, purity and power of absorption; and also the power of resisting the parchmentizing process without lessening the quality of the product. These thin papers are not allowed to absorb more of the acid than is absolutely necessary in preparing parchment in endless rolls, because the absorption increases the porosity in every case. This can be detected by holding a piece of the product toward the light, when it will be noticed that it is covered with numerous small holes. These render it practically useless for wrapping up butter and other fatty products and for preserving commercial goods against water and moisture.

Wood pulp, *i. e.*, ground wood, on the other hand, is quite unsuitable for making vegetable parchment. The sap and resinous bodies which it contains not only spoil the acid mixture, but produce yellowish specks on the surface of the parchment. These specks consist of a combination of the acid and the resin, etc., and parchment made with this material is found after washing to be porous, because the acid has destroyed the wood pulp, preventing its passage to the fibers beneath. It is also an important fact, which must not be overlooked, that when the raw paper is surface-glazed the acid is absorbed with difficulty. It is therefore found necessary not to calender the web of raw paper too much when preparing it for thick parchments, and for the thinner kinds to avoid the calendering altogether.

Bleached straw cellulose can also be used as a raw fibrous stock for parchment making. It is found to give it a transparent appearance. Linen fibers, on the contrary, render the parchment opaque. Half stuff, which has been quickly prepared, also produces the same effect. Great care must be exercised in the preparation of endless rolls of parchment from paper composed of these fibers.

Vegetable parchment for every kind of purpose is prepared, as a general rule, with sulphuric acid. Several other reagents, such, for example, as a concentrated solution of chloride of zinc, have been used, but good results are not so easily obtained with them as with sulphuric acid. Moreover, nearly all other reagents which have been proposed are more costly than this acid. The method of manufacture consists in simply passing a sheet of bibulous or unsized paper through a bath of vitriol, which transforms the fibers or cellulose composing the paper into a skin-like membrane resembling a bladder. Hence the origin of the name.

So perfect has this manufacture become at the present time that some kinds of thick vegetable parchments, viz., those used in bookbinding, can scarcely be distinguished from animal parchment. It is, *par excellence*, grease and water proof; but, owing to the demand for such papers, several kinds of imitation vegetable parchments are manufactured now in vast quantities, which, although they differ very widely in many features from the real article, yet possess some properties in common with it which enable them to replace it in many directions. Vegetable parchment, for example, does not fall to pieces when immersed in water, but retains its tough, pliable nature and regains its original strength when dried again. On the contrary, the so-called imitation parchment is easily torn when damped, and therefore, for wrapping up butter, fish, etc., is not so suitable. Indeed, vegetable parchment is applicable to a hundred and one uses for which the imitation kind is wholly unsuitable.

### THE MANUFACTURING PROCESS.

The machine used for conveying the roll of bibulous paper through the several troughs is constructed of materials which will resist the corrosive action of the sulphuric acid. In general arrangement it is not unlike an extensive tub sizing apparatus, with this difference, that the web, after passing through the acid and other troughs, is cleansed with water as it passes over a platform of wooden rollers. These and all other rollers are driven with ordinary belt gearing in the same way as a paper machine. The trough containing the sulphuric acid is the first of the series, and is immediately followed by another which contains dilute acid after the process of parchmentizing has been going on for a short time. These troughs are made of wood and lined with sheet lead. The rolls for guiding the paper through them, some of which are submerged in the liquids, are made of glass or porcelain, or some such acid-resisting material, while the press rolls, placed above the troughs, used for gently squeezing the excess of acid from the web, are made of a special kind of India rubber. These rolls, as may be imagined, are expensive, and on that part of the machine where it becomes possible, viz., where the washing begins, they are substituted with hard wooden rolls. The washing is usually effected by directing jets of water from a series of spray pipes, placed at equal intervals along the machine, but running across the web of wet parchment. These water pipes play upon the top and under surface of the parchment, the latter being supported by a platform of wooden rolls as mentioned above. Beneath each washing platform a large wooden trough is placed to receive the slightly acid (or alkaline) wash water, and at the further extremity of each trough a pair of press rolls presses the excess of water from the sheet before it passes on.

After the web of paper has passed through the acid bath, squeezed and partly washed by passing through a water trough and over the first washing platform of rolls, it would still retain a very large amount of acid, and if this acid were left in the parchment, rapid destruction of the product would follow. For many years, however, the acid thus left in the parchment at this stage of its manufacture has been neutralized with ammonia. For this purpose an ammonia bath, consisting of a small wooden trough containing diluted ammonia, is placed between the first and second washing platforms or troughs. It contains a submerged roll, under which the parchment passes to thoroughly saturate it with alkaline fluid. The parchment, after traveling through it, runs over a roller placed above the level of the liquid, and from thence into the water of the next washing trough, into which it simply dips, and then, passing upward, travels over the horizontal platform of rollers, where it is further washed on both sides with the water sprays. At this stage the web is tolerably clean or free from ammonia salts, but to be perfectly sure that this is so, it is again pressed between a pair of small rubber rolls to partially dry before it is plunged into the next washing trough in the series. It then passes over another platform of rollers as above described, and, finally, again pressed to get rid of the excess of water before it is dried on the drying cylinder.

The drying cylinder (sometimes more than one is employed) is constructed in the same way as those of an ordinary paper machine, the wet parchment being held against its surface by the aid of a felt. There is also a pair of glazing rolls with which the parchment is glazed before it is reeled.

The first operation in the manufacture of the parchment is passing the prepared paper through the acid bath. To do this successfully and easily it is necessary to have proper arrangements for filling and emptying the acid bath. The oil of vitriol or sulphuric acid is usually mixed to the required strength in a separate vessel, where it is stored ready for use, and from which it can be conveyed by gravitation to the working bath on the machine. This store tank is sufficiently large to hold a good supply of acid. The acid is mixed by hand; and as its specific gravity should be maintained at a constant figure, owing to its hygroscopic nature, it should not be allowed to remain exposed to the air for any length of time. In some works, pumps of special construction are used to convey the acid from one vessel to another; but this is said to be a costly and unpleasant method.

The oil of vitriol prepared for the acid bath should possess a sp. gravity of 1·636 (127° Twad. or 56 Baume), and be uniformly mixed. This acid contains, substantially, 72 per cent. real anhydrous sulphuric acid and 28 per cent. of water. Ordinary 80 per cent. (145° Twaddell) oil of vitriol may be used to make the mixture, but in every case special attention must be paid to its temperature before it is run down to the acid bath. This should never be allowed to exceed 62° Fah. (17° Centigrade), otherwise its action upon the paper is too severe. It is sought in actual practice to keep the acid as cool as possible, and to avoid rapid changes of temperature. To accomplish this conveniently, many different schemes are in vogue. Some makers, in order to regulate the temperature, and to insure that the acid is cold, pass it through a pipe immersed in a stream of cold water, while others introduce cold water coils of lead pipe in the store tank and also in the working bath. In any of these cases the temperature can be regulated sufficiently well, provided the supply of cold water is efficient.

It is usual, however, to make the acid a little stronger to begin with, viz., 1·665 sp. gr., in order to make allowance for its hygroscopic properties, etc. To ascertain whether it acts well, the workman draws a piece of the raw paper through it while in the bath on the machine. By experience he can tell if it is in proper condition. If the raw paper has been well made and of good quality, and all other conditions in proper order, little difficulty will be experienced in passing the beginning of the endless roll through the acid bath and over the other parts of the machine. It would be difficult for the novice to tell whether he was bringing forward good paper or making parchment which was quite unsalable. The experienced parchment maker can, however, tell what it really is whenever it leaves the acid bath. With this specialty it is not as in other papers where the machine plays an important part in

their manufacture. Success lies more in the direction of the condition and quality of the raw paper and acid mixture.

Obviously it is of the highest importance to apply only as much of the acid as is necessary for the preparation of a good product, because in this there is great economy. Care is therefore taken not to use more acid than is absolutely necessary to yield the desired result. The paper as it unrolls from the reel dips into the acid bath, and after the excess of acid has been scraped and squeezed from it, it passes into the first washing trough, at an angle of about 60°. The wash water contained in this trough very soon becomes strongly acid, and on the score of economy is preserved to be concentrated for reuse. It is also apt to become hot, owing to the fact that sulphuric acid generates heat when diluted with water; care must consequently be taken that the temperature is kept low. Many works intercept a part of the working acid in the second and third troughs and reconcentrate it in leaden pans, but it depends upon the proportion of acid thus caught and its strength, as well as upon the cost of fuel and the situation of the works, whether such a system of acid recovering pays or not.

The speed of the machine is also of great importance. This should be maintained at a uniform rate of speed, otherwise the parchmentizing, washing, and drying are somewhat uncertain. The level of the acid, too, in the acid bath is maintained constant, so that when the speed of the machine is once fixed, the depth to which the paper passes into the bath is a measure of the time given for parchmentizing.

There are many other points to which attention should be paid when drawing the raw paper through the acid. This work is greatly facilitated if the reels are free from faults and otherwise perfect. The presence of moisture in the paper, or water getting into the acid bath, causes much trouble. Many stoppages are caused if the web is not continuous, and if any broken pieces are made during the parchmentizing process or in the subsequent washing, neutralizing, and drying, etc., these result in a serious loss, as they cannot be worked up again like "broke" in ordinary paper mill practice. When the sheet of paper passes equally through the acid, the washing sprays are allowed to play equally upon both sides of the sheet, and if the machine is not arranged so that this can be done efficiently, the faults produced cannot afterward be removed. The paper must be treated in accordance with its thickness and breadth, and this can alone be properly done by the experienced parchment maker having a thorough knowledge of the nature and peculiarities of the raw material and condition of the machine he is working.

The web of parchment, after passing through the ammonia bath, is slightly alkaline, the whole of the acid being "killed" by the ammonia. It is only necessary, therefore, to insure that it is thoroughly washed to get rid of "fixed" ammonia salt (*i. e.*, sulphate of ammonia) and a little free alkali before it is finally dried and glazed. A copious supply of water is therefore used to thoroughly cleanse the parchment at this stage, and after excess of water is squeezed from the sheet by a pair of rubber press rolls it passes over the drying cylinder, then through a pair of iron glazing rolls before being finally wound on a reel. The prepared parchment is then cut up into suitable sized sheets and placed on the market in reams.—*Chemical Trade Journal.*

## MARSHALL'S PAPER PULP FINISHER.

SINCE the invention of the Dutch cylinder stuff engine for the finishing of paper pulp the principle of the work has scarcely varied.

Whatever be the changes introduced into the construction of beating apparatus, the course of the fibers is always longitudinal in them, by reason of the natural law that forces every floating body to take this direction. The drawing action of the roller of the engine further favors such longitudinal motion. It naturally follows therefrom that the fibers present themselves at right angles to the cutting surfaces, and this has the effect of chopping them rather than of opening them or separating them longitudinally. Such inconveniences manifest themselves particularly if the apparatus is not regulated by a skilled and careful workman, if the pulp does not remain long enough in the engine to undergo the crushing effect of the roller and if the fibers are not reduced through friction between each other.

Numerous arrangements have been invented for preventing the fibers from being cut rather than crushed and for effecting the separation of them, but none of them has completely answered expectations.

The Gould type, with vertical disk revolving upon a horizontal shaft, is the one that comes nearest to attaining the object proposed, in the sense that the fibers present themselves in a direction much more parallel with the comminuting surfaces than they do in other apparatus; but the objection made to it is the excessive consumption of motive power and the impossibility of employing it for dissolving dry sheets of waste paper.

Mr. Marshall has taken up Gould's idea and has at the same time borrowed from the Jordan engine its conical part, not without providing it with some improvements. Upon combining these two arrangements, he has been led to create a new triturator, which not only performs the role of a finisher, but also completes the process of comminution, so that the finishing and mixing are effected by a single passage through the machine.

The disk, imitated from Gould's last type with its counterpart, presents a wider surface of trituration than the conical part and is designed to separate the fibers longitudinally, that is to say, to open them or pull them apart. The large quantity of work absorbed by the Gould apparatus is reduced in a large measure by the suppression of the friction of a considerable weight of pulp projected in a few seconds against the sides of the old apparatus, and which took about 70 per cent. of the power employed.

The new finisher is represented in the accompanying figures. Its conical and fixed box, $A^1$, is provided in the interior with about 220 bent steel blades with intervals filled with hard wood liners. These latter are formed of three thicknesses of glued wood, thus facilitating their hollowing in measure as the steel blades wear away. At the wide extremity of the cone, and upon its circumference, is screwed adisk, $B^1$, capable of being brought near to or removed from a movable plate by means of a hand wheel, $B^2$. The vertical surface of this disk, which is about 1·10 meter in diameter, is provided with 210 bent steel blades, 12·5 millimeters distant from each other, with intervals filled with hard wood.

In the conical box, $A^1$, and opposite the disk, $B^1$, revolve respectively the cast iron cone, A, of the same form and the disk, B, both keyed to the forged steel shaft, S, which is 150 millimeters in diameter and makes 300 revolutions per minute. These rotary parts are carefully balanced in order to prevent any jarring. The first carries upon its surface 72 longitudinal straight steel blades, whose interspaces are filled with hard wood. The same is the case with the second, which, placed at the extremity of the revolving cone, is provided with an equal number of straight and thick steel blades radiating around the shaft, and separated also by wooden liners.

The parts of the shaft passing through the stuffing boxes of the two extremities of the machine, like those situated upon the cap, C, that covers these latter at the wide extremity of the cone.

Between the two cones of this apparatus the pulp undergoes the final finishing. It is brushed therein or elongated according to the degree of proximity of the blades, while the object of the two disks is more especially to open and separate the fibers.

The work is done in a continuous manner. The pulp traverses the apparatus in eight seconds and makes its exit therefrom as perfectly fine paper stuff.

According to data communicated to us by Messrs. Everling & Kaindler, of Paris, the apparatus is constructed in three models, characterized by the following features:

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| Space ..... | 3·75 × 1·30 m. | 3·35 × 1·50 | 2·75 × 0·95 |
| Production per hour ..... | 550 to 650 kg. | 400 to 450 | 270 to 325 |
| Surface of trituration..... | 2·25 m². | 1·35 | 1·11 |
| Power ..... | 40 horse | 30 | 20 |

An ordinary engine, occupying a space of 4·25 m. × 2·10 m. possesses a surface of trituration of only about 25 dm². A comparison of these figures with those given in the preceding table at once shows the superiority of the Marshall finisher. Besides, while furnishing a pulp of better quality, it responds to the present needs of intensive production. The work of manufactories is tending more and more to become continuous, that is to say, to no longer be divided into a number of operations independent of one another. It will finally become so in the finishing of pulps, if not in all manufactories, at least in those that make large quantities of paper of the same kind. Apparatus of great capacity and operating continuously will finally be substituted for the small engines. The hopes founded upon the future of the Marshall finisher are so much the greater in that it is adapted to all kinds of pulp and especially to bisulphite pulp, which it well prepares for felting on the machine and for calendering.—*Revue Industrielle.*

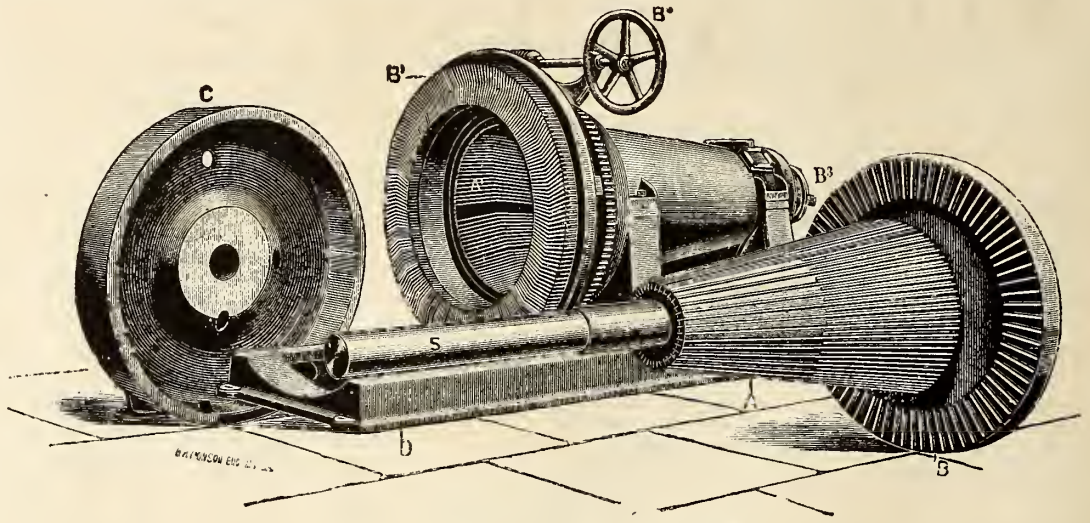



FIG. 1.—PARTS OF THE FINISHER.

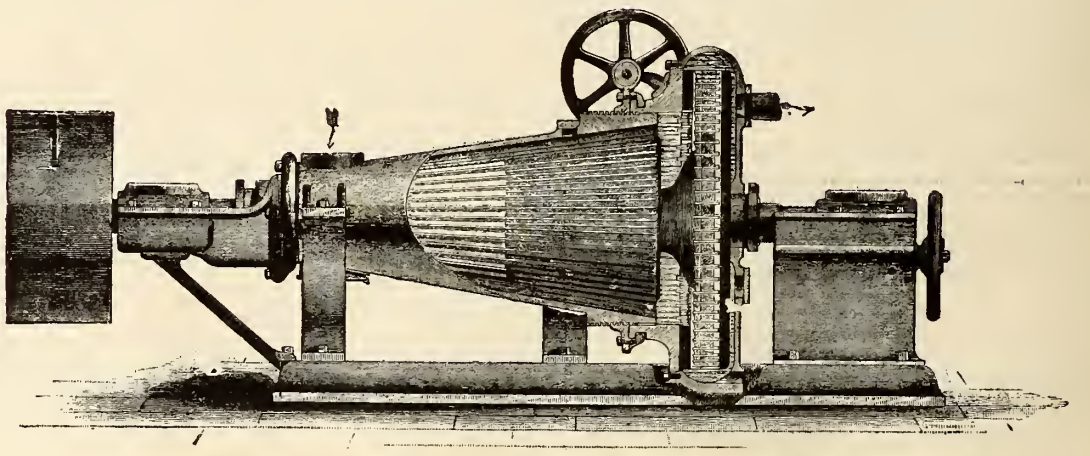


FIG. 2.—LONGITUDINAL SECTION AND ELEVATION.

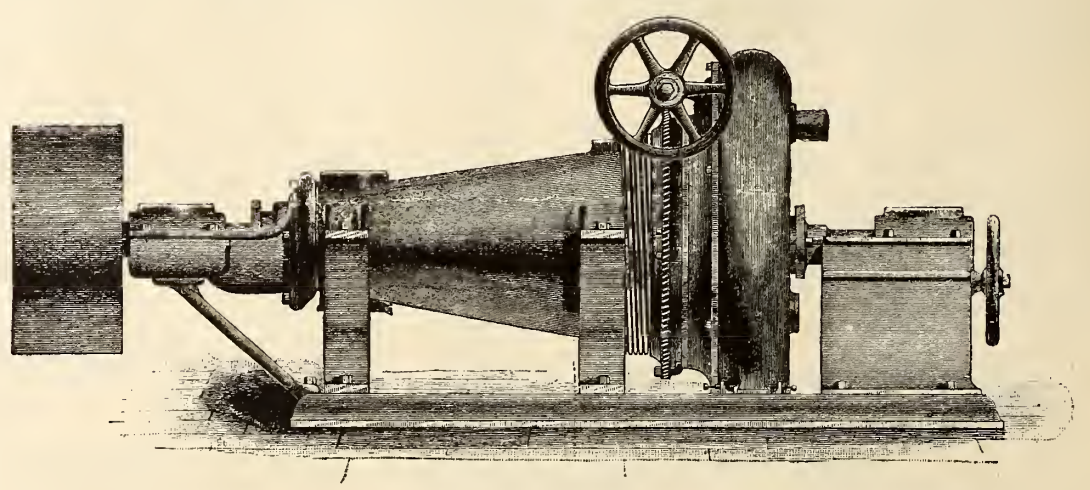
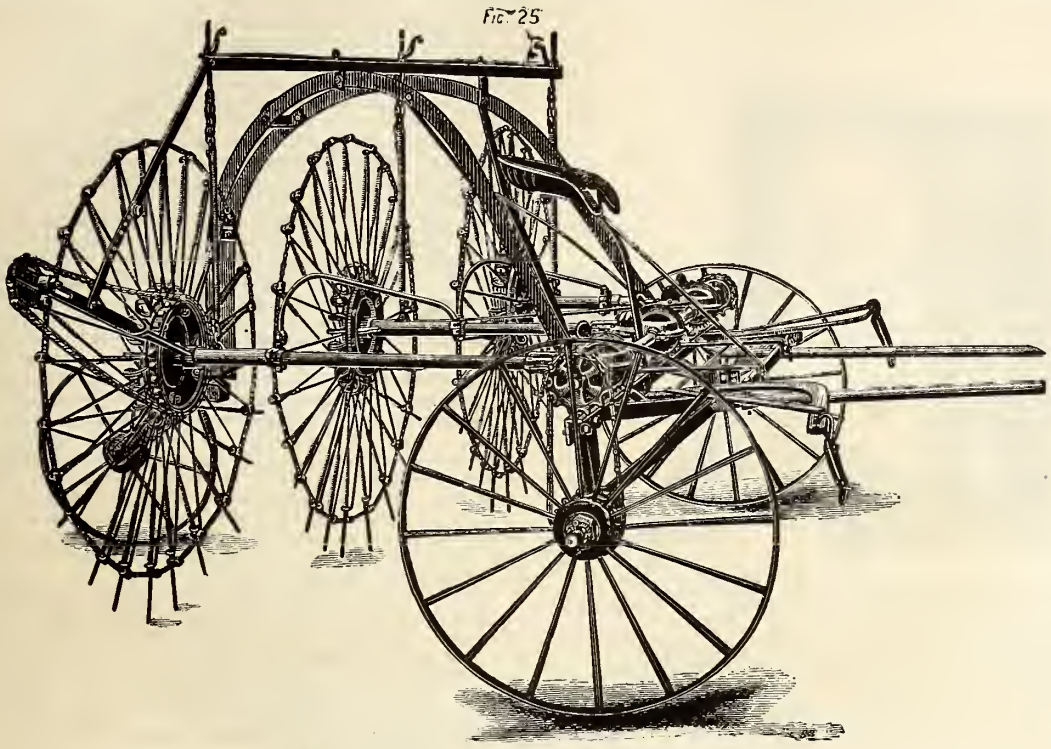


FIG. 3.—ELEVATION.

## IMPROVED HAY RAKE AND TEDDER.

WE give a view of Stoddard's hay rake and tedder, as shown at the Chicago Exhibition, and which especially attracted the attention of foreign visitors. The *Engineer*, London, produced this engraving. The machine is a great labor saver, while, by the thorough and uniform manner in which it turns the grass, it not only hastens the time of curing, but insures excellence in the quality of the hay, so far as good curing can contribute to that result.




IMPROVED HAY RAKE AND TEDDER.

## A PERPETUAL MOTION OF THE EIGHTEENTH CENTURY.

THE search for the impossible perpetual motion, which has captivated so many minds and turned so many heads, was the starting point of a fraud much in vogue and very popular toward the end of the eighteenth century. This deception, executed by certain none-too-scrupulous prestidigitators, responded then to quite a general preoccupation and met with the same success that is at present obtained by the so-called mind reading, which seems to correspond to the serious researches made upon hypnotism.

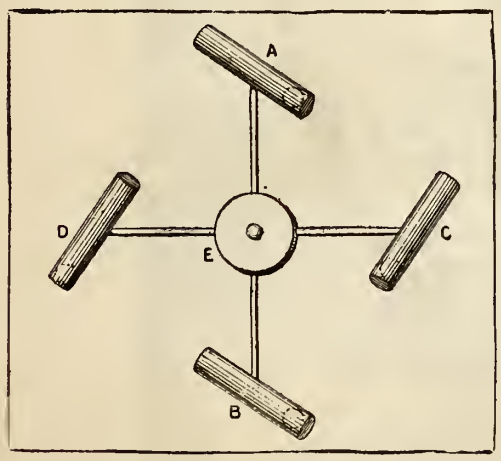
The experiment was executed as follows:

To the wall was fixed a center or disk of wood, E, capable of revolving upon a pivot and carrying four rods placed at right angles. Each of these rods terminated in a tube, A, B, C, D, slightly inclined, closed at the extremities and containing a leaden ball. The apparatus having, according to the assertion of the exhibitor, to revolve constantly of itself, was held by a string, and, when this latter was removed, it set itself in motion, stopping if the finger or any other obstacle was interposed between the branches, and resuming its rotation as soon as the obstacle was removed.

The inventor explained his discovery as follows: "The balls, A and B, are in equilibrium because they are at an equal distance from the vertical line that passes through the center, E. By the construction of the machine, the ball, D, being, on the contrary, more distant from the point of support than the ball, C, must prevail over the latter and break the equilibrium. It must then descend to the point, B, and cause the apparatus to make a quarter revolution. Now the latter cannot take place without the rod, A B, which was situated vertically, assming a horizontal position, and then the balls, A and B, are to each other as were the balls, D C. One must overcome the other and cause the apparatus to make another quarter revolution. This second quarter revolution cannot take place without being followed by a third, through the new position assumed by the balls, A B, etc. The machine is, therefore, so constructed that it must revolve continually until the pivot is worn out and it falls through want of support."

This fine theory, which the slightest examination reduces to naught, was, nevertheless, accepted by the spectators. They could not call it in question on seeing the result before their eyes.

If the spectators had been able to examine things closely, they would have seen that the apparatus did not revolve alone, and they would have perceived one of the means employed, which were numerous. The simplest consisted in causing the apparatus to revolve through the partition, either by means of an endless cord or a belt fixed to the pivot passing through and extending beyond the partition, or by means of a magnet (if the apparatus was small and the partition thin) acting upon a piece of iron placed in one of the tubes. When the apparatus was alleged to be tied up, the person concealed behind the partition remained immovable; but when the apparatus was freed, he moved his magnet circularly or acted upon the belt, and the motion was perpetual—until the spectators had made their exit!—*La Nature.*




A PERPETUAL MOTION OF THE EIGHTEENTH CENTURY.

## NEW ELECTRIC TRAMWAY CAR.

THE reception given by the public to the electric cars that are doing regular service on the lines from Saint Denis to the Opera House, and to the Madeleine, belonging to the Compagnie des Tramways de Paris et du Departement de la Seine, is very favorable, and so the company has accepted the offers that have been made it for the use of electricity upon certain of its other lines. For the last six months it has been making some experiments, especially with an electric car constructed for the line from the Porte Clignancourt to the Bastille. The system of propulsion experimented with is based upon the use of the Laurent-Cely accumulators. While in the Saint Denis automobile cars recourse is had to two trains of gearings to obtain the proper reduction of speed between the dynamos and the axles, a simplification is here introduced that consists in mounting a dynamo directly upon each of the driving axles. It has, consequently, been necessary to give these dynamos a relatively feeble rotary velocity, since they have to make the same number of revolutions as the wheels of an ordinary tram car.

The Breguet works have obtained such a result to the detriment of the weight, and have constructed dynamos weighing 3,200 kilogrammes. These dynamos are designed to furnish 100 amperes at 100 volts, say 10,000 watts Their inductors were suspended from the car frame by powerful spiral springs and the armature was keyed to a bronze tube traversed by the axle and carrying the latter along through an assemblage of recesses. To this effect the axle carried four projections that entered the notches of a disk keyed upon the hollow axle of the dynamo. Between the axle and the tube there were rubber rings for deadening shocks.

These few data suffice to characterize the system of electric car of which trials were made last October. In consequence of the breakage of an axle, attributed to the shock produced by a derailment, it was decided that, instead of actuating the axles directly, it should be done through a train of gearings. Mr. Garnier undertook the study of the construction of the mechanical part, and requested the Societe Anonyme de l'Electricite to construct the electric accessories according to the plans and explanations of Mr. Johannet.

The car thus transformed is ready to be submitted to new trials. We give a view of it in the accompanying figure.

As in the first type experimented with, the Laurent-Cely accumulators are placed in three compartments formed under the seats on each side of the car. Each of them contains two boxes of nine elements connected in series and consisting of 11 plates, 5 of which are positive and 6 negative, and that weigh together 192·5 kilogrammes. The compartments are closed by hinged panels that allow the accumulators to be quickly changed at the company's depot.

One of the peculiarities of the car consists in the use of a new rolling material, including two converging axles and a guiding axle constructed by the Garnier works, with a view to facilitating the passage of the vehicles on curves of feeble radius.

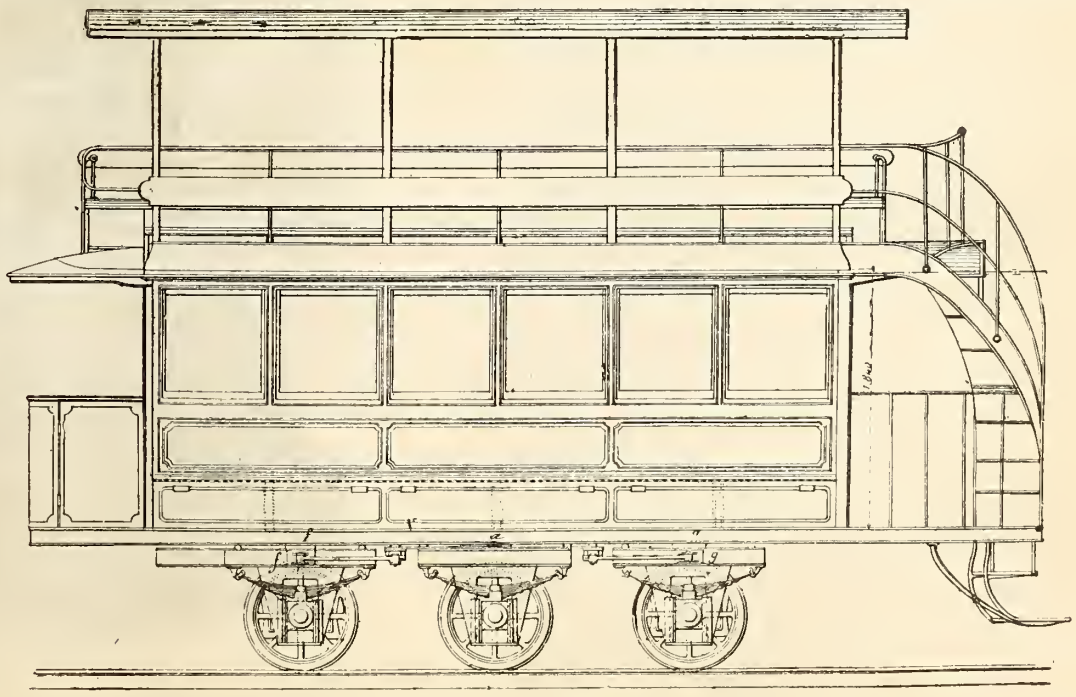
The frame of the car is supported by three independent trucks, the two end ones of which have a driving axle and the other an axle that is both a carrier and a guide. Through this arrangement, the details of which are not here shown, the passage of curves of feeble radius is very easily effected. When the car enters one of them the end trucks pivot around their axes and converge toward the central axle, which remains at right angles with the direction of the car. The front and hind trucks support the body of the car through vertical rollers arranged radially, so as to roll over circumferential bars of flat iron fixed under the frame.

In the first trials this car moved with perfect ease over curves of 12 meters radius, and in the final experiments the manifold advantages of this system will doubtless be confirmed.

In this car, as above stated, a single transformation of speed between the dynamos and the driving axles was adopted. This is realized by means of gearings established in the ratio of 505 to 104·5 millimeters. The utmost care is taken to assure a very smooth transmission of motion and consequently a large rendering. Despite the use of these gearings, a sensible saving in weight is obtained over the first arrangement. The dynamo, as a whole, with its bronze frame, weighs 1,500 kilogrammes. The excellent results furnished by steel for the polar pieces have exceeded anticipations; so it is hoped that in the future the dead weight may be sensibly reduced.

As for the arrangements of the electric material, properly so called, they have been dictated by very judicious considerations.

In the different mountings employed up to the present regard has been paid rather to the necessities of the running of the dynamos selected than to the advantageous conditions of the operation of the batteries. Recourse has always been had to dynamos in series, because they act with more security at the moment of starting, and, in general, at the moment of an increase of the resistant couple. From this standpoint they are self-regulating, the intensity of the current being always proportioned to the tractive stress. One has then been led to cause the potential of utilization of the source to vary by means of combinations in the grouping of the elements of the battery. The inconvenience of this system is striking. If, in consequence of any defect inherent to an element, the electromotive force of such element lowers, the corresponding e. m. f. of the branch of which it forms a part in a grouping in quantity lowers in the same measure. The result is that this branch, instead of furnishing its proper part of energy in the work to be effected in common by all the branches, may, on the contrary, be traversed by a current of charge coming from the other branches, which will thus be doubly supercharged, since they will have to furnish the current that the damaged



NEW ELECTRIC TRAMWAY CAR.

branch ought to have discharged, and, besides. the current of recharge of such branch.

In the new mounting adopted for the car under consideration, Mr. Johannet has especially endeavored to assure the normal operation of the most delicate part of the system, the battery, save requiring of the dynamo a supplementary quick start at the moment desired. which, moreover, it will resist, if it is strong and simple in construction.

The remedy for the inconveniences above cited consists in making the battery always operate with all its elements mounted in tension, but, in return, in producing with the commutator and in the dynamos wound in derivation a variation of the magnetic field in measure with the changes of the tractive stress.

The variations of the field can be obtained either by properly grouping the elements of the inductor windings or by modifying the current of the shunt through the introduction of a variable resistance. It is the latter solution that is applied in the present case.

The commutator that permits of such variations of resistance assures, besides, the reversal of the direction of running as well as the more or less quick stoppage of the car.

To this effect, the commutator carries two dials, one of which assures the different movements to be executed in front and behind, the operation of the brakes and the closing of the inductive circuit, while the other serves to bring about the variations of the magnetic field, which, under all circumstances, corresponds to a more or less rapid operation, according to requirements.

Arrangements are made for avoiding the spark at the moment of the opening or closing of the principal circuit. To this effect, the contact key passes from one segment to the other only after meeting a series of intermediate segments corresponding to variable resistances. The same precaution is taken regarding the current of the shunt.

The entrance of the current into the armatures before the inductors are excited is rendered impossible through the use of an annex key maneuvered by the principal lever for the closing of the shunt, so that the commutator of resistance variation is not provided with an interrupter.

Finally, as every change of motion must take place in the maximum field, a special arrangement assures the automatic return of the commutator belonging to the shunt to the position corresponding to the maximum current every time the principal commutator passes upon a dead segment.

The running forward corresponds to a grouping of the armatures with the source. The same is the case with the running backward, but with a contrary grouping.

In case of damage to one of the motors, it is possible to throw it out of circuit. The other motor suffices to continue the service and carry the car to the depot.

One of the great advantages of electricity consists in the possibility of recovering, in descents, a portion of the electricity absorbed in ascents, by putting to profit the property of reversibility of the electric motor.

To this effect, the application of the brakes and the regulation on a level or on gradients are effected by employing the dynamos as generators, the motive work being borrowed from the car impelled by gravity or the speed acquired.

These generating dynamos give rise in the battery to a current of charge that increases with the intensity of the field, and thus produces a more or less rapid retardation of the car As the lines operated by electricity have very varied profiles. the stoppage through the recovery of electricity may often be usefully applied. It is, when necessary, completed by the action of the blocks of a mechanical brake of the Lemoine system that permits, under all circumstances, of mastering the behavior of the car.—*Abstract from Revue Industrielle.*

## PHOTOGRAPHIC APPARATUS FOR FACILITATING FOCUSING.

THOSE who are but slightly familiar with photographic manipulations always have considerable trouble in focusing, by reason of the fact that the images of the camera are inverted upon the ground glass. Various apparatus, formed of glass plates of large dimensions placed at the back of the camera, have been devised for overcoming this inconvenience; but such arrangements, which are expensive, heavy, and cumbersome, have met with no success.

A small apparatus has just been invented that will permit an amateur photographer to right the image, and to get an idea of the clearness of all the details much more easily.

A word in the first place as to the general precautions to be taken for focusing properly. We extract these from a small treatise upon photography, by Mr. Charles de Mainbressy, which we especially recommend to beginners and even to persons who have been practicing for some time.

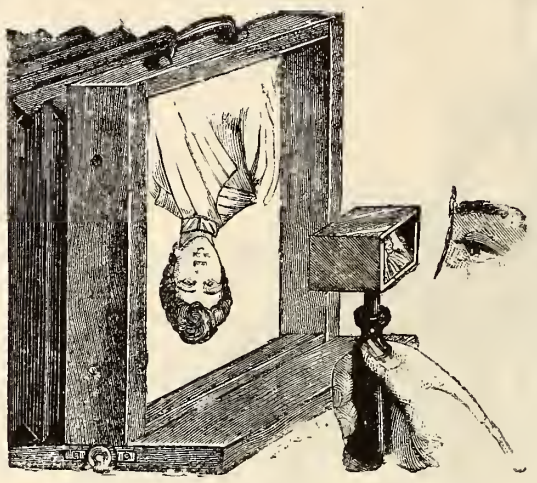
In itself, focusing offers no difficulty. It is done by moving back the posterior end of the camera by means of the button that actuates the rack. When the rack is double, there is a button on each side of the camera. This is the case in all good cameras. Afterward, on covering himself with the veil, the amateur will seek the position in which the image presents itself best upon the ground glass. If the image is too small, the apparatus must be pushed forward, or, if the contrary is the case, it must be drawn back. If necessary, the vertical and horizontal displacement of the objective may be utilized. If, for example, we are photographing a bell, we shall be obliged, in order to bring the image entirely upon the ground glass, to incline the apparatus slightly. The image is then more or less distorted, but this trouble can be remedied by raising the objective. A little practice, however, will suffice to give an idea of all the advantages that can be derived from the various motions of which the camera is capable, and we believe it useless to say that certain views should be taken from a greater or less distance, being given the diminutions of the object to be photographed. When the subject fits perfectly upon the ground glass, the three screws of the foot are tightened in order to assure the stability of the apparatus.

After this we proceed to the exact focusing, which is effected by examining the image with care and close by.

Recourse is sometimes had to the hand lens or to the ordinary watchmaker's lens, which is applied against the glass; but the use of such instruments is in nowise necessary; and it is only when it is a question of obtaining very great precision that recourse is had to them.

If the subject includes very different planes (a landscape, for example), the focusing must be done upon the objects placed at mid-distance. If it is a question of a portrait, the focusing must be done upon the face.

The focusing must be done with the objective wide



open. A diaphragm may be afterward used if it is judged that the sharpness obtained is not sufficient.

After the focusing has been effected, the button that fixes the pinion to the rack is tightened.

We owe to the kindness of Mr. Mendel, the manufacturer of the apparatus, the accompanying figure, which shows the arrangement and dimensions of it. It consists of a special flint glass prism mounted in a frame and provided with a handle. It permits of examining the image, right end up, in all its details. It may be employed with a camera of any form whatever. As may be seen, it has the form of a hand lens with all the convenience thereof. Light and not very bulky, it can easily take its place among the photographer's paraphernalia. The delicacy of the image seen through this apparatus is in nowise altered. It is indispensable for portrait and landscape taking. With it, ridiculous poses may be avoided and one will be able to judge of the artistic value of a negative immediately. —*Le Naturaliste.*

## MISS KLUMPKE.

WALKING in the footsteps of Sophie Germain, Maria Agnesi and Madam Kowalewska, Miss Klumpke, a young American woman, of San Francisco, has devoted herself with talent and success to the study of mathematics, and obtained the degree of doctor of sciences on the 14th of December, 1893.

It is in its application to astronomy that Miss Klumpke has made mathematics a study. Two other young ladies, Misses Bignon and Leblois, had already received the degree of doctor of sciences, but it was the natural sciences that they had made their specialty.

We must not be surprised, however, at the success obtained by young women, in mathematics especially. The female brain, according to the opinion of physiologists, is peculiarly adapted to the study of the exact sciences, and it is by reason of usages and traditions much more than through want of aptitude that examples of the kind that we have just mentioned are not more numerous.

Miss Klumpke is not a new comer in science. She was connected with work on the equatorial in the east tower of the Paris observatory, when the lamented Admiral Mouchez, struck by her very peculiar aptitudes and her high degree of education, distinguished her.

The staff was then employed in making an accurate map of the heavens in utilizing the most recent processes of photography. Miss Klumpke was connected with the work and introduced into it a perfection of researches and a precision that immediately brought her into prominence.

Our engraving represents the young woman doctor in her office at the Paris observatory working at the measurement of photographic negatives, the union of which will form the map of the heavens. In front of her is the apparatus designed for such measurement. It is a large, highly magnifying microscope, strongly constructed of cast iron in order to prevent any shaking or other motion. Its role is as follows: In the first place, photographic plates are selected, and upon them an impression of regularly spaced crossed lines is taken. These plates are then exposed to the heavens twice for about a quarter of an hour. The heavens are photographed thereon, and then, instead of laboriously following the stars in space by means of the telescope, one has, after a manner, an immovable sky, upon which it is possible at one's leisure, with the microscope of which we have spoken, to determine exactly the relative position of each star with respect to its neighbors and the constellations.

Although the apparatus is of great magnifying power, we may judge of the patience and sagacity that it requires to register without error upon the plates these small stars scattered at random and almost imperceptible, and not to confound them with each other. It is here that Miss Klumpke excels. She has already furnished our astronomers with the confirmation of certain scientific hypotheses and opened new vistas.—*L'Illustration.*

MISS KLUMPKE, DOCTOR OF MATHEMATICAL SCIENCES.

## NOTES ON THE TREATMENT AND CURE OF CANCER.

By NICOLAS PIKE.

### THE IMPORTANT DISCOVERY OF THE TREATMENT AND CURE FOR CANCER.

THE medical profession all over the world are giving their attention to the new treatment for cancer and kindred disease by inoculation with erysipelas, as they consider it of great importance to mankind. It is now being put into practice by many skillful professional men in this country and in Europe, and where it has been tried carefully success has been the result. We know of a long-standing case yielding after short treatment, and is now supposed to be entirely well. The importance of this cannot be too highly prized, as the disease until recently has baffled the skill of some of the most learned men of the world. It may be safely said that the medical faculty were wholly in the dark as regards *the causes* and treatment of cancer. It

seems that the disease is on the increase, as a physician informed the writer that for the past ten years the cancer patients doubled that of the preceding ten years.

More than seventy per cent. of these were women, and twenty per cent. were cancer of the breast. Of the many cases which he treated, most of them he operated upon which only gave temporary relief, the disease appearing again in a short time, and in many cases death alone relieved the patients of this terrible and hitherto incurable disease. The medical profession are not generally of the same opinion as to the cause of cancer. Some agree that it is hereditary taint, which is constitutional, others hold that it is a truly local disease. The discussion of this disputed question involves statements of a very complicated kind.

There are many who positively declare that cancers of every description, as well as those of a kindred nature, are caused by eating too much pork and meat, which contaminates the blood. Some members of the French Academy of Medicine assert that they firmly believe that the use of pork as a food is the origin of cancer; many writers of the olden times claim that leprosy, as well as cancer, were caused by eating too much of the same. Others assert that suppressed evacuations, particularly those of a gross habit, excessive fear, grief, anger, religious melancholy, a long-continued use of food that is too hard of digestion or of an acrid nature; colds, blows, friction or the like, and many of our distinguished medical writers on the subject assert that it is hereditary from parents who are afflicted with scrofula.

That the cancer is caused by eating too much animal food seems absurd, as the following statement will show. Surgeon-Major Handly, resident surgeon of the Hospital Japore, India, writes the following in the *British Journal of Medicine* in April last: "M. Reclus has shown that cancer is all but unknown among the persons whose food was exclusively vegetable!" A. Venniel also believed that the increase of cancer was largely due to the large carnivorous habits of diet of the past generation. The records of the Mayo Hospital of Japore, which is under Hendly's charge, show no such immunity of vegetarians from cancer. From January, 1880, to the present date, 102 major operations have been performed in the hospital in cases of cancer. Of these, 41 were on the persons of meat eaters and 61 on those of strict vegetarians, who had never eaten meat since their birth. In India, where caste rules are exceedingly rigid, the fact that the latter were true vegetarians is capable of absolute proof. Among them are six Saraogis, a class of Iains who always reject many kinds of vegetables. Three of these Saraogis suffered from cancer of the breast. Out of one hundred and two cases, there were three deaths attributable to the operation. There is no information available as to recurrence of the contrary. The cases were divided as follows: Cancers of the breast, 20; tongue or lips, 8; head and face, 17; upper extremity 11; lower limbs, 8; trunk, 18; testicles, 1; glands, 3.

There were sixty-three males and forty females, a large proportion of the latter in a country where the Purdah system is in force. The maximum age was 70 years; the minimum age was 18 years; the average was 48 years. Dr. Simms, of Oxford, England. some years ago discovered a medicine which he called *Oxonia*, which was said to cure cancer and kindred diseases.

The Radcliff Infirmary sent their cases to this gentleman when they were pronounced incurable; and all patients with lupus and rodent ulcers were cured by him. Mr. Thomas Christy, F.R.S, of London, was advised to test this wonderful medicine, which he did, and published the result of his experience in a small pamphlet. In his consultation with some of the medical faculty, they requested that his experiments should be put to the most severe tests. It was decided to send down to Oxford some very serious cases of lupus, which had been under treatment for ten or twelve years in the London hospitals. It was thought that this would be a test and settle the question at once. In less than two weeks one man, who had two *perforations* in the cheek and one in the neck; these had all filled up, and the flesh was quite sound, and has remained so for some months without any recurrence. The particulars of this case have been recorded. This medicine has been distributed to some of the most eminent surgeons and medical men in England, who have tried it, and in every case where it has been carefully used it has given great satisfaction. It is now in general use in the London hospitals, and many surgeons positively assert that they are certain, and now able to cure cases of lupus and rodent ulcers very quickly. Sores on the surface or on the nose can be cured in a few days.

Mr. Sydney Turner, F.R.S., and Dr. Plummer, two gentlemen who have been appointed as commissioners to study the cancer and its causes; that they have arrived at the decision *that cancer is entirely produced from external causes*, although several people have put in opposition to this theory at every *post-mortem* examination since, the same conclusion has been arrived at, and they have proved by careful research that, although the cancer may have been in the inside of the body, they have found the original seat of the wound. This thoroughly corroborates the opinions of Dr. Simms, of Oxford, who has held this view for some time, and, acting in accordance with that, has cured numerous cases in all forms by external use. The result of this discovery will in all probability revolutionize the mode of treatment of this and kindred diseases throughout the civilized world. It has been stated that a cancer patient in the New York Hospital was accidentally inoculated with the virus of erysipelas, and, as the disease progressed, it was noticed that the patient's cancerous condition improved. This fact suggested to the physician in charge the importance of inoculating other patients with the erysipelas virus. Several were set apart, and experiments were begun and carried out.

The inoculation of patients with "carcinoma," commonly known as cancer, also on others who were suffering from "sarcoma," which is a more malignant form of tumor than the ordinary cancer. The results were satisfactory. Dr. Bull has stated that there is not sufficient evidence to warrant in saying that the use of erysipelas virus of cases of cancer, excepting as a makeshift. All that has been gained is the confidence that the virus of erysipelas is antagonistic to and would effect a cure in cases of sarcoma, and that it would be a justifiable remedy in such malignant troubles. Sarcoma, a soft, fleshy tumor, is quite as obstructive to life as cancer, but not by any means so frequent. So far as this application to cancer is concerned, the results have been encouraging. They have relieved many patients, but the results did not warrant any such statements as have been extensively circulated through the country. The treatment of erysipelas for the cure of cancer and kindred diseases is not new. It has been experimented with by numbers in Europe. Dr. Babtchinsky, a leading physician of St. Petersburg, Russia, discovered the antagonism which exists between the diphtheria microbe and that of erysipelas in a patient suffering with diphtheria, caused a speedy cure of the latter. Six children were stricken almost simultaneously with diphtheria in one family; five of them were inoculated with erysipelas bacillariæ, and they recovered in a wonderfully short time. The sixth child had been at once removed to a remote part of the city, and died of the dread epidemic. It has been stated later that the doctor has also been successful with erysipelas virus in cancer and kindred diseases. The progress of the erysipelas is a painless and quiet one, not accompanied by unfavorable results upon the general condition of the patient while the cure is being effected. If they have found the real enemy of the cancer and diphtheria, the medical profession will wipe out a foe which demands annually thousands of living beings. Further clinical experiments with erysipelas virus will have to be made before the method of inoculation is employed indiscriminately.

This disease is not confined to the human family, but has been noticed among some of the lower order of animals, such as the dog and cat. We once saw what was supposed to be an ordinary tumor under the chin. It was removed by a veterinary surgeon successfully. After the operation and upon examination it was found to be a true cancer which appeared again during the year, and was the cause of the dog's death. The dog and the cat are more subject to it than some other animals. The horse, mule and pig are next in frequency. It has not been observed in birds, fish or reptiles, and is not transmissible.

## THE DANGEROUS EMPLOYMENTS INQUIRY.

THE Departmental Committee appointed by Mr. Asquith to inquire into the conditions of labor in the chemical, white lead, and allied industries have issued their report.

The committee were directed by the Secretary of State to inquire (1) into the conditions under which lead smelting, the working of blue lead, and the production of white lead, red lead, yellow lead, and litharge are conducted, with the object of diminishing any proved ill effects on the health of the work people engaged therein; (2) as to whether the special rules which already exist with regard to the manufacture of white lead are sufficient; and (3) to suggest any precautions necessary to the industries specified for the protection of life or health.

The inquiry was extended into England, Scotland, and Wales, and the committee visited 46 works and examined 184 witnesses. The reports on those industries of special interest to our readers are as follow:

*White Lead.*—The institution of a medical examination previous to the employment of females; the requirement of a medical certificate after absence through illness, before re-employment, for both sexes; tho prohibition of females under 20 years of age from employment; the requirement of a certificate of birth or baptism, or other proof of age, for females before employment; the reduction of the price of such certificate to not more than 6d.; the abolition of female labor in all processes where there is direct contact with white lead—*i. e.*, white beds, rollers, wash becks, stoves, and packing; the adoption of the overalls and head covering for females in the blue beds and all parts of the works; the provision of shoes and stockings for all females employed, and the enforced wearing of these during working hours; the provision of a hood connected with a fan for packing and storing dry white lead; the provision of a dining room; the provision of a standpipe or hose in the white beds.

*Red and Orange Lead.*—The prohibition of the use of the rake in drawing charges of massicot, or of red lead, or of orange lead, from the furnace; the prohibition of such charges being drawn from the furnace on to the floor of the workshop or factory; the prohibition of packing massicot, red lead, or orange lead, in the same place where its manufacture is carried on; and the provision of a hood, connected with a fan, for packing massicot, or orange or red lead; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes, and towels; the institution of a weekly medical inspection of all persons employed in such works; the provision of the prescribed drink.

*Yellow Lead.*—The provision of fans; the adoption of respirators and overalls for all those engaged in dry processes—*e. g.*, carding yellow yarn, etc.; the provision of an adequate supply of Epsom salts and the prescribed drink; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes and towels.

*Colors.*—The adoption of respirators and overalls wherever dust is generated; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes, and towels; the prohibition of any male young person or female in such works.

*Lead Smelting*—The prohibition of females and young persons from employment in cleaning the flues; the adoption of respirators and overalls for those employed in cleaning the flues; the prohibition of any one working more than two hours in the flue at a time; the requirement that every one employed in cleaning the flues must take a bath before leaving the works; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes and towels.

*Enameling of Iron Plates.*—The institution of a medical inspection of all employes at least once a month; the prohibition of females under 20 years of age from employment in a brushing room; the institution of a medical examination previous to the employment of females; the requirement of a medical certificate after absence through illness, before re-employment, for both sexes; the provision of half a pint of milk and a biscuit for each female employed before beginning work; the provision of a fan to each perforated table or bench; the provision of a dining room and a cloak room.

*The Tinning and Enameling of Iron Hollow Ware.*—The provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes, and towels; the requirement that every one employed must wash face and hands before meals and before leaving the works; the prohibition of taking any meal in any part of the works except in an apartment provided for the purpose; the provision of a dining room.

*To Apply Generally.*—The substitution in all copies of special rules for the words "as to persons employed," of the words "duties of persons employed;" the extension to cases of lead poisoning of the same usage as obtains in cases of accidents—namely, a compulsory report to Her Majesty's inspector of factories and to the certifying surgeon for the district.

The following suggestions are added:

*White Lead.*—The treatment of the washing water from the first tank below the rollers so as to render it free from acetate of lead in solution, or the prohibition of the immersion of the workpeople's hands into this liquid; the provision of food for the operatives; the postponement of the abolition of female labor in processes where there is contact with white lead until January 1, 1896; the adoption of mechanical means for stacking, stripping, drying, and packing white lead; the discontinuance of wearing gloves for manipulating white lead; the adoption of the cambric, bag shaped respirator; the postponement of stripping white beds until they are "mature."

*Blue Lead.*—The careful observance of all cases of lead poisoning which come to the notice of Her Majesty's inspectors of factories, and which have arisen in lead pipe or sheet works, in order to accumulate sufficient *data* on which to base future recommendations.

*The Tinning and Enameling of Iron Hollow Ware.*—The prohibition of the use of lead and arsenic in the enameling and tinning of hollow ware for kitchen purposes.

The report concludes as follows:

The committee are aware that the enforcement of some of the recommendations they have made may appear to operate hardly upon the manufacturer. But they would point out that each of these reforms is actually in force in some works in the United Kingdom. The greatest change recommended by them is the exclusion of females from all direct contact with white lead. The committee have seen four works where no women are employed in the white beds, in the stoves, or in packing. Judging from the experience they have had, they do not believe the number of women who would have to be replaced owing to this provision can be more than 600.

The committee have noticed that the works in which the largest number of cases of lead poisoning have occurred are those where there has been the least expenditure of money and care in precautionary measures for the health of the operatives.

The committee do not think that the precautionary measures they have felt bound to recommend will press so heavily upon employers as to materially hamper them. But they are agreed that in an industry attended with so much risk to life and health as the white lead manufacture, the same precautionary measures must be taken by all classes of employers as an essential to their continuance.

In making the foregoing report the committee have all along borne in mind the paramount claim of the operative, on the one hand to the protection of his health; and on the other, the possibility that, by making changes too sweeping or by insisting on too extensive an expenditure of capital, they might damage and cripple the industry so as to drive it away from the country and so cut off altogether a source of employment for the industrial classes. They are aware that if the manufacture of white lead were absolutely prohibited in the United Kingdom scarcely a ton less would be used in these islands. The competition from abroad—both from America and the Continent—is very keen; but they hardly think that the alterations in and the additions to the special rules that they have suggested will materially hamper the manufacture or unfairly handicap native enterprise; and it is to be remembered that their adoption will at all events serve to satisfy those responsible for the employment of work people in an industry otherwise so dangerous that the employment has been safeguarded by all the expedients which a prolonged and extensive inquiry has brought to light. In the future, no doubt, practical experience may lead to further endeavors in this direction, but at the present stage of scientific knowledge the committee believe that the measures they have proposed include every precaution that can be used in reason and with safety; and if these be accepted and loyally carried out by all concerned, they are of opinion that it will be long before any justification can arise for further interference on the part of the state in the management of these important industries.

Finally the committee desire to record, as the result of their experience, the fact that lead and all its compounds are in a greater or less degree poisonous, and that the handling or use of each or all of them is attended by danger.

## FUMIGATION WITH BISULPHIDE OF CARBON.

By H. DU BUYSSON, Brout Vernet, France.

THE fumigating chest for use with bisulphide of carbon has been employed for many years in the preservation of unpoisoned herbaria, which would infallibly be devoured without this annual or biennial precaution. These fumigations may render great service in the preservation of other objects more useful than the specimens of a herbarium. I shall describe, therefore, the first method used, and every one will know how to apply it to his own needs.

It is in principle a rectangular box of light wood, lined with thin zinc, which is carefully soldered at all joints.

Around the edge of the box, inside, runs a little gutter of zinc, carefully soldered. This gutter is filled with water and serves to make a water seal by means of the flange of the lid, which is also covered with zinc and carries all around a strip of the metal bent at right angles, and long enough to plunge into the water in the gutter. In this way the box is hermetically sealed and the vapors of the bisulphide cannot possibly escape from it.

Botanists now generally poison their specimens, and the fumigating box is seldom used. Nevertheless, it has served me well and I still resort to it from time to time, to preserve such plants as I have not time to submit to the action of arsenic in alcohol or to bichloride of mercury.

The process in question is based upon the great volatility of bisulphide of carbon at ordinary pressure and moderate temperature. The penetration of its vapor is so considerable that we have only to pile up in the chest the mounting-sheets of the herbarium, one above the other, in order to fumigate them. They are penetrated to the very center and eggs, larvæ, and perfect insects, Anobium or Attagenus, are killed. Space should be left and right of the pile for the vessels containing the bisulphide. Those which I use are of zinc and measure 10 cm. long, 6 cm. wide, and 9 cm. deep. There is no risk in prolonging the fumigation; on the contrary, there is but the greater certainty of its being efficacious. Five or six days will be time enough. No limit need be set to the quantity of bisulphide used; what is not evaporated will serve for a new charge.

The disagreeable odor of bisulphide of carbon is not persistent; it is not even necessary to spread open the mounting-sheets; it is only necessary to expose them, unopened, to the air. I would call attention, however, to one very necessary precaution, if accidents are to be avoided. The vapor of bisulphide is very inflammable, and the chest must, therefore, be set in a safe place and not opened near a fire or any flame whatever. It would be risky, for example, to unpack the chest in the evening while holding a lamp in the hand.

As the odor of bisulphide is very disagreeable and may cause discomfort to some persons, all these operations should be performed in an attic or in an apartment of which the windows may be left open as long as necessary.

### PRESERVATION OF FURS AND WOOLENS.

The same process may be used in the preservation of clothing in clothing establishments, civil or military, where Tinea and Attagenus sometimes cause such ravages. Special arrangements may be adopted in establishing fumigating chests or rooms to avoid the settling due to weight and to facilitate the penetration of the gas.

This method makes it certain that we shall not "shut the wolf up in the sheepfold." Articles fumigated are entirely rid of eggs, larvæ, and living insects. They may be shaken out in the open air for greater security and then replaced on the shelves, with the assurance that they will not be found gnawed when next visited.

### PRESERVATION OF THE STUFFING OF FURNITURE AND SADDLES.

Tinea and Attagenus have a marked predilection for horsehair, so that these insects are sometimes found flourishing in the stuffing of our furniture, even that which is in daily use. This process has the advantage of permitting us to destroy them without having recourse to the upholsterer; we need but to construct a fumigating chest large enough to contain a couple of armchairs or more. In the same way we may treat mattresses, eiderdown quilts, or anything which is supposed to contain eggs or larvæ.

I have experimented with a saddle much damaged by moths, and after fumigating it five days noticed no appearance of insects; the saddle was completely penetrated by the vapor and all the moths perished. I kept it two years under observation in order to be assured of the efficacy of the process.

### DISINFECTION IN EPIDEMICS.

I am persuaded that clothing subjected to this process would be disinfected quite as well as by the processes usually employed in certain epidemics, such as typhus, cholera, smallpox, etc. It seems to me that the vapors which penetrate fabrics so well and kill insects so thoroughly would act in the same way upon the microbes which engender epidemics.*—*Insect Life.*

## FORMATION OF SNOW IN BRIGHT SUNSHINE.

TWO solid bodies, one of them yellow, sulphur, and the other black, carbon, unite under certain circumstances and form a colorless and very volatile liquid called bisulphide of carbon, that must be handled with great precaution, on account of its being so inflammable.

The solvent properties of bisulphide of carbon render it valuable for removing grease spots. Although its odor is more disagreeable than that of benzine or spirit of turpentine, it has at least the advantage of disappearing rapidly, in consequence of the quick evaporation of the liquid.

It removes paint from garments with the greatest facility, but not without causing considerable agitation of the mind in those who use it for the first time. At the point rubbed—at the very place where they, to their great satisfaction, saw the paint disappear, they see a large white spot appear, of the nature of which it is difficult to form an idea. The more they brush it, the more prominent the spot becomes. Has the garment been cleaned, then, only to be ruined? Fortunately, such is not the case. In a few instants the spot will have disappeared, never more to return, melted by the heat of the body. The alleged spot, in fact, was nothing else but snow.

The bisulphide of carbon, in order to evaporate, absorbed heat from the garment and from the surrounding air, and there resulted a depression of temperature sufficient to congeal the aqueous vapor of the atmosphere.

Without operating upon clothing, it is possible to show the production of such cold in the following manner:

Far from any flame and even from a hot stove, fill a very small bottle and close it with a cork stopper provided with an aperture in the center. Into this aperture introduce a piece of twisted unsized paper. This should reach the bottom of the bottle and its upper extremity should project about an inch above the cork. At the end of a quarter of an hour the free part of the paper will be seen to be covered with small particles of snow.

The liquid has ascended by capillarity through the paper, just as the oil of a lamp rises in the wick. On reaching the exterior it has evaporated, and the water

contained in the air, being suddenly brought to a temperature of 30° below zero, has congealed.

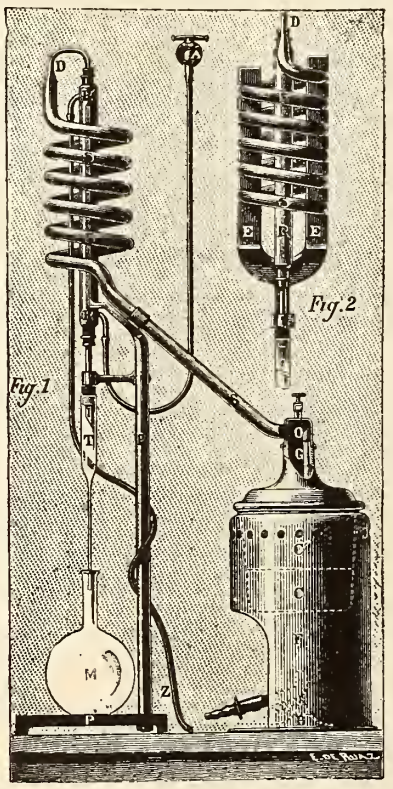
If the upper part of the paper be cut into three narrow strips, well separated from each other (for the whole becomes adherent, through the formation of ice), there are obtained serrated flowers of the most charming aspect, which may be varied in hundreds of ways.

In order to avoid the disagreeable odor of the liquid, it is well to perform this experiment outside of the room, on the edge of a window, for example. The operation can be performed in summer, in bright sunshine. The result will be only the more rapidly obtained, the production of vapor being more abundant.—*Chimie Amusante.*

## DISTILLATORY APPARATUS FOR THE SEPARATION OF ALCOHOL FROM MIXTURES.

WHEN two liquids, alcohol and water mixed, have different boiling points, 78° and 10°, it is possible to separate them when they are in a state of vapor by causing them to circulate in a tube in which condensation can take place through cooling. The aqueous vapor condenses first, while the alcohol remains volatilized until it meets a colder wall, against which it liquefies in its turn, freed from the water that accompanied it. This principle, put in practice by an appropriate apparatus, permits of condensing in a small volume all the alcohol contained in a liquid. This mode of separation is called fractional. It is obtained in laboratories by means of the ball apparatus of Messrs. Lebel and Henninger, or with the Schloesing ascending worm, and in the industries by the tray apparatus.

The new instrument here represented is based upon




DISTILLATORY APPARATUS FOR THE SEPARATION OF ALCOHOL FROM MIXTURES.

the principle of the Schloesing apparatus. It consists (1) of a copper still, C, of a capacity of one liter, resting upon a furnace, F, heated either by a gas burner or an alcohol lamp; (2) of an ascending worm, S S S, of tin drawn out and curved at its upper part, traversing a refrigeratory, R R, and ending in a gauged balloon, M, the whole being supported by a cast iron plate, P; (3) of balloons gauged 1 liter and 500 and 250 cubic centimeters capacity, closed with rubber stoppers, and rigorously comparable with one another, that is to say, the one of a liter capacity having to contain exactly twice that of the balloon gauged 500 or four times that of the one gauged 250 cubic centimeters; (4) of a test glass with foot, well calibrated, capable of holding 300 cubic centimeters of liquid; (5) of two alcohol meters of 0° to 20° and of 20° to 40°, verified by the State; (6) of a thermometer showing the half degree and likewise verified; (7) of a table of alcoholmetric correction; (8) of a bottle of potash pastilles; (9) of several glass pipettes; (10) of rubber washers for the closing of the apparatus; (11) of rubber tubes for the entrance and exit of the water; and (12) of a metallic funnel.

The following is the operating method: (1) accurately measure the liquid to be distilled, in a gauged balloon, either of a liter or a half liter, the leveling being effected by a pipette; (2) decant into the still with a funnel, the balloon being rinsed several times with water distributed over the sides by means of a glass tube, and the washing water being emptied each time into the still; (3) add a few pastilles of potash up to the saturation of the acidity of the spirit; (4) connect the still with the worm by means of the coupling collar, and be sure that the rubber washer is in a perfect state; (5) pass water into the refrigeratory in such a way that it shall flow out in a thin stream upon its exit; (6) place under the refrigeratory the gauged balloon designed to receive the product of the distillation; * (7) light the burner or alcohol lamp and observe the moment at which the first drop distilled falls into the gauged balloon, and then regulate the heat in such a way that the drops shall follow each other rapidly to the bottom of the balloon without forming a continuous stream; (8) when the level of the liquid collected in the receiver is about two centimeters below the gauge mark, extinguish the burner or alcohol lamp; (9) arrest the flow of the water into the receiver; (10) with water taken up by a pipette, make the level of the liquid exactly flush with the gauge mark in the receiver, and then close with the rubber stopper, shake vigorously in inverting the balloon several times in order to well mix, and then rest until the bubbles of gas have entirely disappeared; (11) fill the test glass and slowly immerse the very clean and dry alcoholmeter until it floats of itself in the center of the cylinder; (12) when the oscillations have ceased and the instrument is immovable, proceed to the reading upon the graduated stem in placing the eye at 15 or 20 centimeters from the test glass and at the level of the liquid; (13) read the division that corresponds to the trace of the horizontal plane passing through the lower meniscus; (14) take the temperature and refer to the tables that accompany the apparatus, in order to calculate the real alcoholic value and divide the result obtained by two.

A foamy liquid can be accurately measured only after being freed from the excess of gas that it contains through agitation in a receiver of greater capacity. In order to avoid too complicated corrections of volume, it is important to introduce into the still only liquids that are not too far from the temperature of 15°. During the distillation, it is well to assure one's self that the water that leaves the refrigeratory is scarcely tepid. If the contrary were the case it would be necessary to increase the discharge. When there is no water supply in the room in which one operates, the inconvenience can be obviated by installing in a corner and above the apparatus a tubulated bottle or a cask provided at the bottom with a cock to which the rubber tube is adjusted. If necessary, the water that makes its exit from the refrigeratory can be poured back into the reservoir and be used anew; yet the colder it is the more quickly the operation is effected.

With this new apparatus one is sure of concentrating the totality of the alcohol into a volume half less, when it is a question of liquids whose alcoholic value does not exceed 20°. When one has to deal with spirituous liquids, take 250 cubic centimeters of the liquor, decant them into the still, fill the balloon anew with water that one adds to the boiler, distill and collect 250 cubic centimeters in the ganged balloon that has served as a measure. In this case the value observed is the real one, after correction due to the temperature.

All the operations are executed with a guarantee of a tenth of a degree, according to the verified experiments that have been made.

The apparatus, permitting of dividing the products of distillation, is very well adapted to the separating of the small quantities of alcohol remaining in vinasses, which is something that no other instrument would do. For certain tests, either because one has need of following the ebullition of foamy liquids or of operating upon small samples, or for any other cause, one may have to use a glass balloon. To this effect, although in all respects it is preferable not to interrupt the continuity of the worm, the apparatus may be so constructed that upon unscrewing the obturator there may be adapted in its place a rubber stopper provided with an aperture, and itself fitting in a glass balloon.—*La Nature.*

## POTASSIUM.

H. DAVY, in 1807, made the momentous discovery that potassium hydroxyd, which had thus far been considered an element, can by the galvanic current be decomposed into a metal, potassium, and O and H. He employed a very powerful voltaic battery of 200 pairs of 4-inch plates, while to-day we carry out this electrolysis more easily by means of Bunsen's elements. For the production on the large scale at present a different process is applied, viz, tartar is carbonized in a covered crucible and this intimate mixture of potash and carbon is exposed to the strongest white heat. According to the equation:

$$K_2CO_3+2C+3CO+K_2$$

is CO and metallic K obtained which volatilizes at this heat and is blown into a recipient which is half to two-thirds filled with petroleum in which the K accumulates without being oxidized. Potassium is a silver-white metal with strong luster which at the ordinary temperature possesses the consistence of wax, is brittle below 0° C., and melts at 58—62·5° C.; specific gravity, 0·865; voluminary weight 39. It oxidizes immediately in the air, and is, therefore, kept in a liquid free from oxygen, such as petroleum. On heating in the air it burns with a violet flame. The violet coloration of the colorless flame of a Bunsen burner is characteristic for all potassium compounds, and it is best recognized by observing the flame reaction through a blue glass.

As we have seen in the contemplation of water,

* NOTE.—I have observed in bisulphide of carbon no clearly defined power of taking out the colors of fabrics which I have subjected to its vapor. It may, therefore, be used without fear, except perhaps in the case of the most delicate tints.

* When a liter is operated upon the half liter balloon is placed, and when a half liter is operated upon the 250 cubic centimeter one is placed.

potassium decomposes water with extraordinary energy under liberation of H, which ignites and by the volatilized K burns violet gray.

Of the potassium salts are, besides potash, only tartar, potassium bichromate, potassium permanganate, alum, the prussiates and tartar emetic of interest for the dyeing and bleaching industries; but as the active principle of these potassium compounds does not dwell in the K, they must be reserved for future consideration at the proper places. Potassium hypochlorite, which, under the name of eau de javelle, is known as bleaching liquid for vegetable dyestuffs, requires no special consideration, since it is for bleaching technics much too dear, out of the question.—*Textile Colorist.*

## THE FORMENEPHONE FOR THE MUSICAL ANALYSIS OF GASES.

IT is under the above somewhat strange title that we are going to present to our readers an absolutely new principle of analysis, which permits of determining the quantity of a foreign gas contained in the air by means of the sound produced by the gaseous mixture in passing through sonorous pipes. It is to Mr. E. Hardy, one of our most distinguished physicists, that we owe this original discovery. The learned experimenter first applied it to the search for fire-damp in coal mines. We shall describe the apparatus that he has constructed, but shall first give a succinct historic *resumé* of the researches that have been made in order to ascertain the presence of fire-damp in mines.

Every one knows the terrible catastrophes that fire-damp so often causes in coal mines. Fire-damp is, as well known, composed essentially of formene or marsh gas. This is the gas that disengages itself from the mud of stagnant water when a stick is thrust into it. Mixed with air in the proper proportion, it detonates violently in contact with an ignited body. In order to combat fire-damp, we have ventilation only. On sending a large quantity of air into a mine, we dilute the fire-damp and carry it to the exterior. In order to prove its presence, we have only the aureola that

FIG. 1.—HARDY'S FORMENEPHONE IN OPERATION IN A COAL MINE.

it forms around the flame of lamps. This aureola appears around the flame of ordinary lamps only when there is already 3 or 4 per cent. of fire-damp mixed with the air, and then danger is approaching. It is true that improved lamps exist that are designed for the detection of fire-damp, but we always forcedly remain, with the aureola, in the presence of an appreciation of a phenomenon difficult to seize. Moreover, as fire-damp collects at the top of the galleries on account of its lightness, the height of the chimney of such lamps prevents researches being made at the places where they would be most necessary, for the fire is often seen running at the top of the galleries like a train of gunpowder, and threatening a catastrophe if it happens to reach regions where the proportion of fire-damp is a little larger.

There exist also very accurate scientific apparatus,

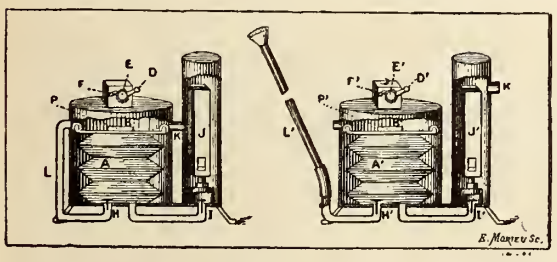



FIG. 2.—THE FORMENEPHONE.

A A', bellows; B B', cords winding around the crank shaft; D D', H H', I I', valves; L L', suction pipes; J J', organ pipes; E E', ratchet wheels; F F', clicks; D D', cranks; P P', weights.

especially the Coquillion fire-damp indicator, improved by Mr. Grehant, for measuring the quantity of the gas existing in the air, but they are too delicate to be used outside of the chemist's laboratory, and, moreover, require a certain length of time (nearly twenty minutes) for making a verification.

Mr. E. Hardy, as we have said, has just devised a very original and certain method, as well as an apparatus called a formenephone, designed to make known in a few seconds the presence and the quantity of fire-damp or of any other gas mixed with the air.

The following is the principle upon which the formenephone is based: When we cause two organ pipes of the same pitch to sound at the same time, by means of two distinct bellows supplied with pure air, we obtain a single sound. All being thus regulated, if one of the bellows, instead of being supplied with pure air, be supplied with a mixture of air and a gas not having the same density, the sound of the corresponding organ pipe will be modified, and the two pipes sounding at the same time will give more or less frequent vibrations, according as there is more or less foreign gas mixed with the air.

With a little practice one can easily estimate the quantity of it approximately. In fact, the organ pipes giving the *ut*[1] and the gas mixed with the air being formene, we obtain the following results:

For 1 per cent. of formene in the air, we have about 1 vibration per 3 seconds.

For 2 per cent. of formene in the air, we have about 3 vibrations per 2 seconds.

For 3 per cent. of formene in the air, we have about 2 vibrations per second.

For 4 per cent. of formene in the air, we have about 3 vibrations per second; and so on, the vibrations increasing in frequency in measure as the gaseous mixture becomes richer in formene. When it reaches 12 per cent., we have about 9 vibrations per second. At 20 per cent. they become very frequent, and at 25 per cent. extremely frequent, but always very clear and very distinct.

It is to be remarked that the vibrations are very easy to count with accuracy when they are not very frequent. If, then, we do not wish to allow the fire-damp to exceed a certain determinate limit that would give the formenephone say three vibrations per second, it will always be easy to remain below this limit in counting the vibrations by means of a simple seconds watch. We must also remark that it is possible for a determinate quantity of fire-damp in the air to render the vibrations of the formenephone more or less frequent, by changing the pitch of its organ pipes. The higher the pitch, the more frequent the vibrations, everything else being equal. We shall see further along a very exact method of counting these vibrations even when they are very frequent.

The principle enunciated above gives rise to two types of apparatus: (1) The portable formenephone designed to analyze in a few seconds a mixture of air and a gas not having the same density, and especially to verify the state of the fire-damp in a mine gallery. This apparatus is represented in Fig. 1 in operation in a mine. In Fig. 2 we give an explanatory section of it. The device consists simply of two bellows, A and A' (Fig. 2), and of two organ pipes, J and J'. One of the bellows, A, and its organ pipe, is inclosed in a tight metallic drum containing pure air, which is only put in circulation by the bellows in order to make the organ pipe speak, and never leaves the apparatus. The other bellows, on the contrary, takes in the mixture of air and fire-damp by means of movable tubes, L and L', at the most convenient place, even at the top of the gallery. A special arrangement permits of freeing the gaseous mixture of the dust and carbonic acid that it may contain.

Weights, P and P', bear upon the top of each bellows and are fixed thereto. These weights can be raised and the bellows be opened by means of levers, D and D'. Ratchet wheels, E and E', and their clicks, F and F', keep the bellows open. It suffices then to free the two clicks at the same time by pressing on their tail in order to make the two organ pipes speak at the same time and give vibrations, if there is any fire-damp in the gallery. (2) The fixed formenephone of continuous indications, the bellows of which are actuated by any sort of small motor (electric, water or compressed air), is capable not only of making its vibrations heard in the gallery in which it is installed, but at a distance in one or more offices. To this effect, a microphone is installed upon each of the organ pipes. The current from a battery traverses them in succession and afterward passes through an ordinary telephone receiver. Under such circumstances, if the receiver is put to the ear, we hear the pure sound of the pipes if there is no fire-damp, or the vibrations repeated with perfect clearness if there is any fire-damp in the gallery. In order to avoid putting the telephone receiver to the ear, the receiver is replaced by a microphone amplifier. This latter is formed of an electromagnet mounted upon the poles of a permanent horse shoe magnet. A vibrating steel plate is more or less attracted by this electromagnet, according as the current coming from the microphone has undergone more or less variation in intensity. The vibrating plate carries a finger, at the extremity of which is inserted a conical carbon. A very light spring, insulated electrically, carries a flat carbon that rests upon the conical one. The current from a local battery traverses these two carbons and passes through a telephone receiver of large dimensions provided with an ear piece.

Under such circumstances, the variations in intensity of the current coming from the microphone are shown by greater variations in intensity in the current of the local battery, so that the receiver provided with the ear piece repeats the same sounds as the microphone, but in amplifying them considerably—about four hundred times, and even many more in certain cases.

In order to obtain results of great precision or to preserve a trace of the quantity of fire-damp that is found at a given moment in a mine gallery, the vibrations of the formenephone are marked upon the revolving cylinder of a registering apparatus upon which is marked also the second. It is then possible to count exactly the number of vibrations per second, and to thus know with great accuracy the quantity of foreign gas mixed with the air.

Up to the present we have spoken almost exclusively of the use of the formenephone for the analysis of mixtures of air and formene, but it is equally adapted to the analysis of mixtures of air and any other gas not having the same density, and especially mixtures of air and carbonic acid. Installed in a room of ordinary dimensions, it gives vibrations due to the air vitiated by the carbonic acid of respiration, when such room has been occupied for a few hours by but one person.—*La Nature.*

## OIL OF COPRAH AND PALM OIL.

AT from 30° to 31° the oil of coprah, if pure, is soluble in twice its volume of absolute alcohol. At the same temperature palm oil is soluble in four times its volume of absolute alcohol. If mixed with sparingly soluble vegetable oils or animal fats to the extent of 1-20th or less, both become almost insoluble in the same quantity of absolute alcohol, the solvent action of which does not occasion a fractioned separation of the component parts. The mixture has acquired solubility which is peculiar to it, and which does not depend on the proportions of soluble fatty matters of which it is composed.

These differences of composition enable us to determine with precision the purity of these solid oils, a chemical analysis of which often gives uncertain and even contradictory results, especially for slight admixtures.

*First Process.*—Shake up for one minute, in a test tube graduated in c. c., 20 c. c. of the oil under examination with 40 c. c. of alcohol at 95°. This indispensable preliminary treatment may give certain indications. Alcohol at 95° absorbs a certain quantity of the neutral fatty substances, and the oil itself dissolves from 15 to 20 per cent. of alcohol. The solvent power of the oil decreases appreciably on the addition of oils insoluble in alcohol at 95°, such as castor and resin oils—oils which may then be easily characterized by their very distinct chemical and physical properties.

*Second Process.*—In a test tube graduated in c. c., treat 5 c. c. of the oil of coprah (previously washed with alcohol at 95°) with 10 c. c. of absolute alcohol, and place the tube in a water bath heated very exactly from 30° to 31°. After some moments the tube is taken out, shaken very briskly for thirty seconds, and returned to the water bath. Pure coprah oil dissolves entirely, and the alcohol solution is perfectly clear.

Coprah oil mixed with insoluble oils (the commonest sophistication), arachid, sesame, cotton, maize, etc., does not dissolve appreciably, and forms a turbid mass with the absolute alcohol, from which it quickly falls in fine drops to the bottom of the tube, where it collects. Oil of coprah containing palm oil is precipitated when the proportion of the mixture reaches 20 per cent. Below that mixture the liquid remains turbid.

The verification of palm oil is effected in the same manner, using 20 c. c. of absolute alcohol instead of 10 c. c., and operating always upon 5 c. c. of oil at the temperature of 30° to 31°.

Five c. c. of palm oil containing 20 c. c. of coprah or upward dissolves in 15 c. c. of absolute alcohol; in the same proportions the pure oil does not completely dissolve, and the mixture remains turbid. The purity of coprah and palm oil cakes is found by extracting a sufficient quantity of oil by means of any solvent and treating in the same manner.—*Comptes Rendus.*

## BORON BRONZE.

By H. N. WARREN, Research Analyst.

THIS alloy, or more correctly speaking, aluminum-boron bronze, is brought about by the introduction of aluminum containing boron, not as aluminum boride, but existing as graphite does in cast iron. Commercially, this part of the process is accomplished by heating in a specially constructed oxyhydrogen furnace an admixture of fluorspar and vitrified boric anhydride, until the dense fumes of boron fluoride commence to appear. At this stage, ingots of aluminum are introduced into the liquid mass; reduction at once takes place, with the formation of free boron, which dissolves in the aluminum, rendering it crystalline and somewhat brittle. When this so prepared aluminum is alloyed with copper to the extent of from 5 to 10 per cent., a bronze is obtained, denser and more durable than ordinary aluminum bronze, and free from brittleness; but the most peculiar property is the perfectness with which it casts and melts; whereas, in the manufacture of aluminum bronze, one of the greatest difficulties is to insure a uniform mixture. Often a very difficultly fusible alloy of copper and aluminum is formed upon the surface of the already melted portion, and accompanied by superficial oxidation, thus obstinately refusing to alloy with the remainder. But in the case of the boron compound no such difficulties are met with, the alloy melting perfectly, and at lower temperature than when employing pure aluminum. Boron, in fact, seems to have been little studied, but it is evidently not so serious an enemy to cope with as its halogen silicon, which, when present in minute percentages only, determines the total ruin of the bronze with which it alloys; in other words, it stands almost entirely opposite to other elements, entering into the formation, and forming compounds with the more

refractory metals with the greatest ease; for instance, borides of iron, manganese, nickel, cobalt, etc., may be readily formed by the reduction of their accompanying borates in the presence of carbon, while those of silver, copper, gold, etc., can only be formed by the introduction of elementary boron into the fused mass; borides of the alkali metals, and even calcium, barium, etc., have also been obtained, but boride of mercury still holds out.—*Chem. News.*

[Continued from SUPPLEMENT, No. 944, page 15091.]

## ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

*Lecture III.*†

IN the last course of Cantor lectures on "Alloys," I described the experiments which led me to the view that the effect of impurities added to gold is nearly proportional to their atomic volumes, the larger the volume of the atom the greater being its effect. The results attracted much attention, and the Institution of Mechanical Engineers appointed a strong committee in order to ascertain whether the action of impurities on masses of metal is in accordance with the periodic law of Mendeleeff. Two reports have already been presented by this committee, from which it appears that while the law does apply to iron, it is only partially true in the case of copper.‡

A fact of considerable industrial importance was established in connection with the use of copper for fire boxes for steam boilers, as it was shown that the presence of a small quantity of arsenic is positively beneficial, and not harmful, as it has hitherto been supposed to be.

Many points of interest in connection with the constitution of alloys were developed in the course of these reports, and one relating to the effect of pressure on the molecular change in fusible metal may be mentioned here.

It has long been known§ that when a triple alloy of bismuth, lead, and tin, which bears Newton's name, is cooled down from the molten state, there occurs, long after the metallic mass has solidified, a remarkable rise in its temperature. Experiments made in view of the report show conclusively that this evolution of heat occurs generally at 46° C. An evolution of heat also takes place if the solid mass is cooled rapidly by quenching in water. This effect, however, disappears after the third or fourth heating, but may be restored by remelting the mass, or by raising it to a temperature just below its melting point. A suitable alloy for the experiment is the one containing 50 per cent. bismuth, 31¼ per cent. lead, and 18¾ per cent. tin. The appearance of the fractured surface of the mass, if broken before the evolution of heat, is plate-like, crystalline, and almost vitreous; but after the thermal change the fracture is gray, dull, and finely grained. It will be evident that the changes this alloy undergoes present certain analogies to those which take place in steel during the "hardening" by rapid cooling from a high temperature, and when the metal cools slowly from bright redness. In the latter case, if low carbon steel be the subject of the experiment, there are at least two distinct evolutions of heat, one at 855° C., due, it is believed, to a molecular change in the iron, and the other at 655° C,, arising from a change in the relation between the carbon and the iron. Newton's alloy, now under consideration, contains three constituents; and the alteration which is made evident by evolution of heat must clearly be due either to a change in the mutual relations of the constituent metals or else to polymerization or redistribution of the atoms in the molecules of the solid mass, either of which changes is attended with the evolution of heat. That molecular modification does take place in these alloys during cooling has been shown by E. Wiedemann‖ and by Spring.¶ In steel, carbon is present, and complicates the problem under examination, which is not the case with Newton's alloy; but in the latter it is possible that one or other of its three constituent metals may play a part analogous to that of carbon.

A careful study was therefore made of the behavior of the alloy, and it may be well to publish the results in full at some future time; at present it is only necessary to summarize the conclusions to which the investigation appears to lead. The question arises, Is the quenched Newton's metal the analogue of hardened steel? First, as regards change of volume; Ermann, and afterward Kopp, found that the expansion of similar alloys is abnormal. The present experiments show that the change from the vitreous variety of the alloy to the finely crystalline one is accompanied by an expansion in its volume of about 0·8 per cent. Steel also expands during the operation of hardening. The tenacity of the alloy in the vitreous state is very low, only about 1 ton per square inch; but after the molecular change a maximum of 2¼ tons per square inch is attained, the effect being the same whether the change has taken place spontaneously or has been induced by rapidly cooling the alloy. Annealing the bars at a temperature of 80° to 90° C., after the molecular change has taken place, appears slightly to increase their strength. The alloy solidifies at or about the temperature of 96° C., with a range of pastiness extending over several degrees, which prevents any mechanical measurements from being made until the mass has cooled to about 92° C. Throughout the range of temperature between 92° and 80° C. it contracts at an average rate of 0·000144 of its length per degree Centigrade; and the contraction continues, but in gradually decreasing amount, until at 49° C. it ceases, and the metal commences to expand. The amount of the expansion is considerable, nearly one per cent. of its linear dimensions, and appears to be due to some process resembling that of combination, for it requires an appreciable amount of time for its complete development, and is accompanied by a considerable evolution of heat. If, on the other hand, the alloy be cooled too slowly, the evolution of heat is not well marked. The converse phenomena of contraction with absorption of heat, noticed upon reheating the alloy, does not occur at the expected temperature, but at a higher one; and the fact that the change is not truly reversible supports the view that the molecular change in the alloy is due, as is doubtless the case in steel, to combination on cooling and to dissociation on heating occurring in the solid mass.

Under these circumstances it became interesting to see whether the application of pressure would cause the change to take place at a lower temperature than that at which it would occur without pressure. A steel die was formed with a surrounding water-jacket (Fig. 4). The plug of the die had a steel socket, in which

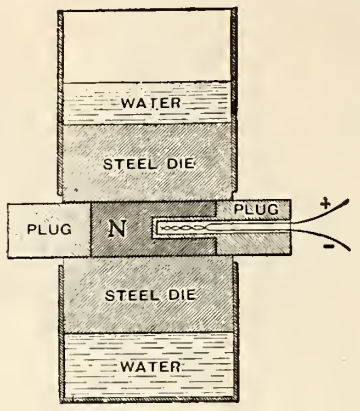



FIG. 4

the thermo-junction was inserted, so that the pressure did not come upon it in any way. This was found to be necessary, as otherwise the insulation failed, and the metal was "squirted" along the wires, causing a short circuit. The alloy, N, was poured into the cavity of the die, which had previously been lined with several folds of paper; the die was closed and placed in the press, and then heated until the metal again became fluid. A steady stream of cold water was then run through the water-jacket, and, by the thermo-junction, inserted in the socket before mentioned, an autographic record of the temperature was taken, while pressure was steadily applied to the die. It had previously been found that the abnormal rise in temperature in the absence of pressure was coincident with the expansion of mass. The result of the experiment showed that, under a pressure of one ton per square inch, the temperature at which the thermal change took place was lowered as much as 4° C., and that a pressure of about four tons per square inch was sufficient to obliterate the thermal disturbance altogether. It is interesting, therefore, to see that, where the pressure is sufficient to cause the particles of the mass to assume the quasi-fluid state, the changes are greatly modified.

The effect of pressure in lowering the critical point in this alloy is evident; and it was interesting thus to ascertain whether the compression of the mass had really prevented the alloy from undergoing the molecular change from the vitreous to the gray variety, or whether the "recalescence" had been so gradual that there was no sudden augmentation of temperature in the cooling mass, such as would be indicated by a marked discontinuity in the autographic curve. The die was accordingly made in halves, so that it could be rapidly opened when the pressure was released. The solid cylinder of compressed alloy was removed and fractured with as little delay as possible; but it was found that the change, though not complete, was far advanced. It is impossible to say whether the change occurs directly the pressure is removed or during the time it has been applied.

The profound change which is produced in the properties of metals by alloying them is well shown by some recent experiments by Professors Dewar and Fleming.* The diagrams, Figs. 5 and 6, will serve to make

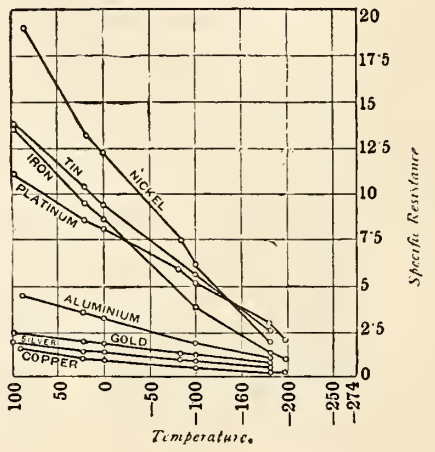



FIG. 5.

clear the nature of their remarkable results. They have examined the effect of very low temperatures on the electrical resistance of pure metals and alloys; and the results tend to prove that, if pure metals could be reduced to the absolute zero of temperature, they would offer no resistance to the passage of an electric current. This is true of soft, pliable metals like gold and rigid ones, such as nickel. Impure metals and alloys behave very differently; the diminution of resistance by exposure to cold is very marked, but the direction of the curves representing resistance and temperature appears to indicate that the resistance at the absolute zero of temperature would still be considerable.

Mr. Laurie has continued his researches by which he determined the electromotive force of alloys, with a view to obtaining indications as to their molecular grouping. His work on the tin-copper series was referred to in the last course. He now shows that if the method he previously adopted be applied to the alloys formed from zinc, tin, lead, and cadmium, which are grouped together by Matthiessen as forming mixtures only with each other, the electromotive force rises at once on introducing only a small quantity (about 1 per cent.) of the more pristine metal, thus confirming Matthiessen's view. The method has also been applied to the tin-gold alloys with the following results. Matthiessen found, on plotting the conductivities of these alloys, that the resulting curve resembled a W, having one maximum point and two minimum. He

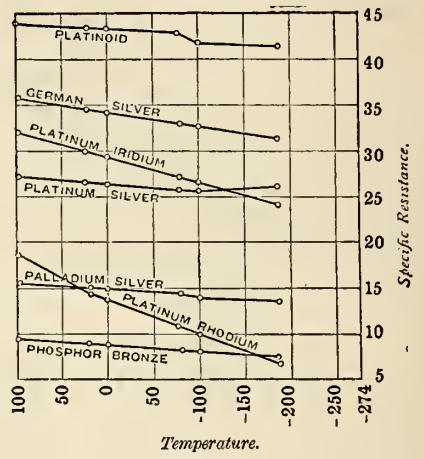



FIG. 6

therefore suggested that probably three chemical compounds existed, corresponding to the three points. The electromotive force method, however, does not altogether confirm this view. One compound is shown to exist corresponding exactly with the maximum point of the curve. Mr. Laurie has suggested that probably this result gives the correct interpretation of Matthiessen's curve, and that only one compound exists. The compound may, from its behavior, be regarded as if it were the dip of the curve on each side corresponding to the curves obtained by Matthiessen for other metals where no compound exists, but where a small trace of one metal profoundly alters the properties of the other metals with which it is mixed.

The analogy of alloys to natural silicates has been pointed out by Mr. H. M. Howe, who also shows that the action of impurities on alloys resembles that of foreign matter in silicates; for, as he says, the presence of one or two per cent. of soda would at once alter the fusibility of any silicate.

Mendeleeff* also shows that the crystallization of igneous rocks is similar to the behavior of certain metals forming a homogeneous alloy from which definite crystalline compounds separate as the mass cools. As evidence that certain alloys have a constitution which resembles salts, he says that an alloy of sodium and zinc is, in a wide sense, a salt in many of its reactions, for it is subject to the same double decompositions as sodium phosphide or sulphide, which clearly have saline properties. The latter when heated with ethyl-iodide forms ethyl-phosphide, and the alloy of zinc and sodium gives zinc ethyl; that is, the element (P, S, Zn) which was united with the sodium passes into combination with the ethyl

$$RNa + Et\,I = REt + Na\,I;$$

hence, the alloy of zinc and sodium is a saline substance in the same sense that sodium sulphide is.

The following circumstances may also be observed: With chlorine, sodium gives one compound; with oxygen, at the most three; with sulphur, five; with phosphorus, probably still more; with antimony, naturally, still more; the more analogous an element is to sodium, the more varied are the proportions in which it is able to combine with it, the less are the alterations in the properties which take place by this combination, and the nearer does the compound formed approach to the class of compounds known as indefinite chemical compounds. In this sense, a silicious alloy, containing silica and other acids, is a salt. The oxide, to a certain extent, plays the same part as the soda, while the silica plays the part of the acid element which was taken successively by zinc, phosphorus, sulphur, etc., in the above examples.

Such a comparison of the silica compounds with alloys presents the great advantage of including under one category the definite and indefinite silica compounds which are so analogous in composition; that is, it brings under one head such crystalline substances as certain minerals, and such amorphous substances as are frequently met with in nature, and used artificially prepared, as glass, slags, enamel, etc.

If the compounds of silica are substances like the metallic alloys, then (1) the chemical union between the oxides of which they are composed must be a feeble one, as it is in all compounds formed between analogous substances. In reality, such feeble agencies as water and carbonic acid are able, although slowly, to act on and destroy the majority of the complex silica compounds in rocks. (2) Their formation, like that of alloys, should not be accompanied by a considerable alteration of volume, and this is actually the case.

Dr. Alder Wright's† experiments on the distribution of a constituent of an alloy between two other constituents considered as solvents must be consulted in his original papers, which are too elaborate for useful abstraction here.

The same must be said of Colonel Edward Matthey's‡ very interesting and important papers on the "liquation" of alloys of precious metals. Working with masses of metal worth thousands of pounds, he has done more than any recent experimenter to clear up

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† This lecture was an experimental one, and is here given in a somewhat abbreviated form.

‡ "Proc. Inst. Mech. Engineers," 1891, p. 543; and 1893, p. 102.

§ Ditte, "Lecons sur les Metaux," 1891, part i., p. 21.

‖ Wiedemann's "Annalen," vol. iii., 1878, p. 237.

¶ "Bulletin de l'Academie Royale de Belgique," vol. ii., 1886.

* "Phil. Mag.," vol. xxxiv., 1892, p. 327; vol. xxxvi., 1893, p. 271.

* "Principles of Chemistry," vol. ii., p 112, note 21.

† "Proc. Roy. Soc.," 1889-93.

‡ "Phil. Trans.," vol. lxxxiii., 1892, p. 629.

this curious molecular behavior of alloys, which is of so much industrial importance.

There can be no question that the general interest in alloys deepens daily, and one very gratifying indication of this fact is afforded by the notes on alloys which have from time to time been published in recent volumes of *Industries*. The appearance of these notes, which deal more particularly with alloys of industrial importance, renders it the less necessary to do more, in the brief space of these lectures, than pass in review those particular portions of research connected with alloys which appear to afford the most hope of immediate progress.

[Continued from SUPPLEMENT 944, page 15090.]

## STUDIES OF THE PHENOMENA OF SIMULTANEOUS CONTRAST COLOR; AND ON A PHOTOMETER FOR MEASURING THE INTENSITIES OF LIGHTS OF DIFFERENT COLORS.*

By ALFRED M. MAYER.

*A photometer for measuring the intensities of differently colored lights.*—It has already been shown that, in certain conditions of illumination and in certain directions of sight, a screen formed of perforated cardboard covered with translucent paper appears with complementary colors, and that if the screen be in the form of a disk with alternate sectors cut out of it, and is illuminated on one side by daylight and on the other side by lamplight, the blue of one side of the disk and the orange of the other appear intensified on slowly rotating the disk. On increasing the velocity of rotation the complementary colors gradually blend, and when the velocity of rotation has banished all flickering light from the disk it appears nearly white. The side facing the daylight has a slight yellowish tint; the side facing the lamp appears whiter, but is tinted with a feeble bluish hue.

To study more minutely these phenomena I made a disk which could be readily taken apart and mounted with different translucent papers, and have attached to it disks and rings of various colors. I shall call this disk *the photometer disk.* It is made as follows:

Two disks, 13 cm. in diameter, and having eight sectors cut out, as shown in Fig. 13, were made of thin

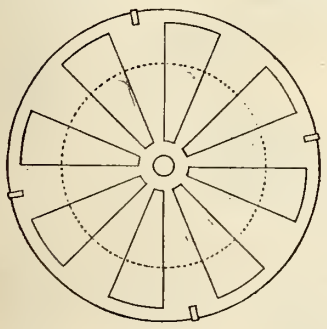


FIG. 13.

Bristol board. A circle of 2 cm. in diameter was left in the center of the disk, from which the cardboard sectors radiate. The border of the disk is a ring of ½ cm. wide, which was painted black. Clamps made of thin hammered brass held these disks together.

Between these disks was placed a circle of the same white translucent paper used in the construction of the large contrast color screen, Fig. 1, and the disks were clamped together with the open sectors of the two disks coinciding in position. A black disk of 8·2 cm. in diameter was placed on each side of the photometer disk, thus leaving between it and the black peripheral ring an annular space of 1·9 cm. wide, formed of alternate spaces of cardboard and of translucent paper. The disk was mounted on a rotator and placed opposite two silvered mirrors inclined at an angle of 150°; an arrangement similar to that of Letheby for observing the disk of Bunsen's photometer. The plane of the disk of the rotator bisected the angle formed by the mirrors, as shown in Fig. 14,

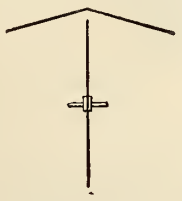


FIG. 14.

so that the surfaces of both sides of the disk could be seen simultaneously, or, rather, in rapid succession. On rotating the disk while illuminated by daylight on one side and by lamplight on the other, the side illuminated by daylight appeared white tinted with yellow; the side facing the lamp appeared white tinted with blue. The hues were the same as described in the experiment with the large disk, Fig. 8, only the surfaces appeared brighter by contrast with the black center and border.

The feeble character of the hues on the photometer disk led me to hope that I could bring these to the same hue on both sides of the disk by the effects of contrast. To accomplish this I placed on the daylight side of the photometer disk a compound disk formed of three split disks, one of red lead, one of chrome yellow, the other of white Bristol board. On the lamplight side I placed a disk formed of three split disks, colored ultramarine, emerald green, and one of white Bristol board. On rotation, the compound disk on the daylight side gave an orange yellow; on the lamplight side the disk gave a bluish green. These colors corresponded in hue to those seen on the respective sides of the ring of the photometer disk when it is rotated, only the hues were much more saturated. After a few trials I brought, by the contrast effects of these colored disks, the tints on the two sides of the ring of the photometer to the same hue; the translucent ring appearing white, with a very slight orange yellow tint on both of its sides. The greenish blue had by contrast effect obliterated the blue tint of the ring and even replaced it by a very feeble orange yellow; while on the other side of the ring the orange yellow disk had diminished the orange yellow tint of the ring to the same feeble orange yellow as seen on the other side of the ring.

Experiments were now made to test this apparatus as a photometer. Equality of illumination cannot be determined with any precision if the two surfaces compared differ even slightly in hue. Here we had the hue to deal with on both sides of the ring; which condition is different from the Bunsen photometer, on which we have two colors on each side of the disk. Various methods were tried to render reliable the comparison of the illumination of the two sides.

(1) I used the eye alone, regarding only the portions of the ring on the border near the mirror, shown in Fig. 14.

(2) Two prisms reflected the images of portions of the sides of the ring nearest the mirror to juxtaposition, as shown in Fig. 15.

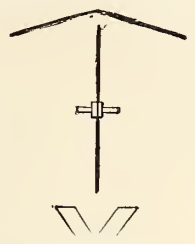


FIG. 15.

(3) A tube blackened on the inside, with a black screen on the end next the disk, as shown in Fig. 16, was used. The eye was thus shielded from extraneous light and the comparisons of illuminations were made, as in experiments 1 and 2, on the portions of the rings which were nearest the mirror as shown in Fig. 16. Vision through this screened tube gave the best results.

After practice in such comparisons, made during

FIG. 16.

several hours on different days, I became more and more skillful and the results of measurements become more concordant; but such methods of photometry do not approach the accuracy of those in which two contiguous surfaces of different degrees of translucency coalesce into one surface of a uniform illumination, as happens on the balance of illuminations on the two sides of a Bunsen photometer disk when these are illuminated by lights of the same intensity and of exactly the same hue. A photometer for this mode of observation is described in the following section. It has, however, the advantage over the Bunsen photometer in that it serves to measure the intensities of differently colored lights.

*The rotating disk photometer.*—The photometer disk was taken apart and a ring of thin white linen paper* of the diameter of the disk and 9·10 cm. wide was laid on one of the disks; this was covered by the circle of thin translucent white paper and on this was laid another ring of the thin linen paper. The other sectored disk of cardboard was placed on these and the disks were now clamped together. The outer portions of the open sectors of the disk were thus closed by two thicknesses of the thin linen paper with the "alba tracing paper" between them, *a*, in Fig. 17; while the inner portions of the sectors were closed by the tracing paper alone, *b*, in Fig. 17.

On rotating the disk, it was not possible to balance the colors of the outer half (*a* in Fig. 17) of the ring

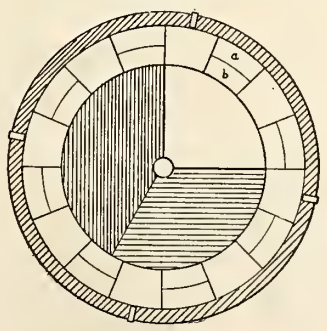



FIG. 17.

formed of three thicknesses of paper, with the same central colored disks used in the previous experiment, when one side of the disk was illuminated by lamplight, the other by daylight. But on increasing the saturation of the hues of the central disks and adding peripheral rings of the same hues, I succeeded in making the hues the same on both sides of the photometer ring. If equality of hue can be obtained when the photometer is illuminated on one side by lamplight and on the other by daylight, then the contrast colors may be brought to the same hue when the photometer is illuminated on one side by a candle or petroleum flame and the other side by the electric arc light or by the whitest Welsbach incandescent lamp.

With a change of distance of the petroleum flame from the photometer the differences in the illumination of the portions, *a* and *b*, Fig. 17, of the ring were changed. When the two sides of the ring were equally illuminated the rings, *a* and *b*, appeared indistinguishable, fusing into one ring of uniform tint and illumination, of the breadth of $a + b$.

With the best Bunsen photometer disk* I was unable to decide where it received equal illumination on its sides, so difficult was it to judge of equal brightness of the blue and orange on one side when compared with the orange and blue in the same respective positions on the other side of the disk.

With a petroleum flame of 40 candle light giving power on one side of the rotating photometer and a candle on the other, the delicacy of the indications of the rotating photometer equaled, and even slightly excelled, those of the very best Bunsen photometer disk.

If we bring in succession the translucent sectors of the rotating photometer disk between two lights, we observe that, on certain sectors, *a* and *b* appear as one surface of the same uniform tint and illumination; on other sectors sometimes *a*, sometimes *b*, is the brighter. Rotation of the disk entirely destroys such slight differences, and the disk then acts as if made of absolutely homogeneous material, placed in the same conditions of contact of the layers of paper, in each translucent sector.

*The hue of the light of "a white incandescent Welsbach lamp" compared with daylight.*—When the screen, Fig. 1, is illuminated on one side by the Welsbach lamp and on the other by daylight, the side of the ring of the screen facing the daylight appears a feeble blue decidedly tinged with violet. The side of the ring facing the Welsbach lamp is colored greenish orange. This greenish orange was matched in hue, but not in luminosity, by a rotating disk having 41·5 parts of red lead, 41·5 of chrome yellow and 17 of emerald green, viewed illuminated by daylight. This appears to be the hue of the Welsbach light when compared with daylight.

*Experiments in which are compared the hues of the light of an incandescent Welsbach lamp and of candle light.*—When "a white light incandescent Welsbach lamp" is placed on one side of the large screen, Fig. 1, and a candle, or petroleum flame, on the other side, the cardboard ring of the screen facing the Welsbach light appears of a light bluish green; the side of the ring facing the candle, or petroleum flame, appears of a light carmine.

Matching these hues on the rotator with split disks gave the following results when the two sides of the screen were equally illuminated. The hue of the ring on the side facing the Welsbach lamp was matched by 8 parts of emerald green, 10 of cobalt blue, 25 of ivory black, and 57 parts of white Bristol board, as seen illuminated by the Welsbach lamp. The hue on the side of the ring facing the candle or petroleum flame was matched by 12 of carmine, 17 of ivory black and 71 of white cardboard, as seen illuminated by the petroleum flame.

*Experiments with the rotating photometer disk placed between the Welsbach lamp and the petroleum flame.*—On rotating the photometer disk, without any central disks, between these lights, the same hues as those already described were seen on its sides, only these hues were much less saturated.

The white disks placed on the sides of the rotating photometer made the hues less saturated.

With a white disk on the petroleum flame side and a black disk on the Welsbach lamp side, the difference between the hues of the sides of the photometer was more pronounced.

With a disk of cobalt blue, emerald green and white on the Welsbach light side and a white disk on the petroleum flame side, the side of the photometer facing the Welsbach lamp appeared white and the side facing the petroleum flame was less carmine; the differences in hue being less than in any of the previous experiments.

By trial I found that when a disk of 33 parts of emerald green, 42 of cobalt blue and 25 of white was placed on the Welsbach lamp side of the photometer disk, with a ring of the same hue on the periphery and a disk of 75 parts of carmine and 25 of white was on the petroleum flame side of the photometer disk, with a ring of the same hue on the periphery of the photometer, the sides of the photometric ring of the photometer had the same hue; which was white tinged with just a perceptible carmine.

We are now in condition to make an interesting experiment which shows in a striking manner the effects of the colored central disks and peripheral rings on the colors of the photometric ring of the photometer. The exact balance of hue on both sides of the photometer has been obtained. Reverse the photometer disk with its central disks and rings and rotate the disk in front of the mirrors. We now see the photometric ring with strong contrast of color on its sides, and the concentric rings, *a* and *b*, are separately seen, not appearing indistinguishable, as in the previous experiment. By the reversal we have, by the effects of the colored disks and rings, added to the effects produced alone by the lights.

It is to be noted that the colors on the disks and rings of the photometer must not be too saturated in hue. The elementary disks of these compound color disks should be made of thin Bristol board, and after they have been painted should be well flattened before they are slit radially. After the proper hues have been obtained for the disks which correct the color of the photometric ring the same hues should be painted on single disks, which are subsequently flattened. The thinner the color-correcting disks and the closer they fit to the photometer disk, the greater is their contrast color effect. The colored rings must be cut out of the painted cardboard, for if the rings are painted after they are formed, it is very difficult to make them flat.

To render easy the making of this photometer I made experiments so that one could get the proper hues of the correcting disks and rings by mixtures of

* From the *American Journal of Science*, vol. xlvi., July, 1893.

* The best paper I have experimented with for this purpose is watermarked "Crane & Co., Dalton, Mass., Bond, No. 21."

* The best Bunsen photometer disks I have used are those sold by the American Meter Company, of New York. They are made in England.

definite weights of the pigment powders and definite volumes of gum water; but it is less troublesome to paint a few disks with colors variously saturated and repeat the experiments I have described, and thus furnish one's self with the sets of disks and rings necessary for the photometric measures of the arc electric light, of the Welsbach white burner, etc., when compared with the standard candle or petroleum flame.

The rotator on which the photometer disk is revolved should be made as shown in Fig. 18, so that the

FIG. 18.

standard, S, and the pulley, P, which is driven by the wheel, W, shade as little as possible the rotating disk, D.

*Photometric measures with the rotating disk photometer.*—On one side of the photometer was placed "a white Welsbach burner" with a light-giving power of 33 candles, on the other side a standard candle. As the candle was gradually brought nearer the rotating photometer the illumination and hues of the portions, *a* and *b* (Fig. 17), of the photometric ring approached equality, and when the candle was at a certain distance the difference of illumination and hues of *a* and *b* become indistinguishable, and only a band with a breadth of $a + b$, with a uniform surface, was observed on the sides of the photometric ring.

The measures of the intensity of the light of the Welsbach lamp in terms of the standard candle were made by a friend. He made sixteen measures with my rotating disk photometer and sixteen with the Bunsen photometer.

The mean of the series of measures made with the rotating disk photometer differed from the mean of the departure of the maximum and minimum measures from the mean by 1·49 per cent. of the mean intensity of the light of the Welsbach lamp.

The mean of the series of measures made with the Bunsen photometer differed from the mean of the departure of the maximum and minimum measures from the mean by 5·22 per cent. of the mean intensity of the light of the Welsbach lamp.

## THE TALKING WATCH.

THE prestidigitator asks of the spectators the loan of a watch and chain. Having obtained it, he holds

FIG. 1.—PRESTIDIGITATOR SHOWING THE TALKING WATCH.

the watch by its chain with the right hand, and it begins to strike.

"I beg your pardon, sir," says he to the owner, "I asked you to entrust me with a watch, but I should have preferred that it had not been a repeater."

"But my watch is not a repeater," says the owner.

"Indeed, it is, sir," says the prestidigitator, "and I am going to profit by it in questioning it. How do you say yes (the watch strikes); and say no (the watch remains silent). Very well, with yes and no we can converse at our ease. Are you very fond of your owner? (the watch is silent). Would you rather remain with me? (the watch strikes). Henceforward, then, you will remain with me (great clatter of bells). See how glad it is. In order to appreciate your qualities, I am going to ask you a few questions."

"Be kind enough, sir," says the prestidigitator to the owner, "to give us two different figures, and the

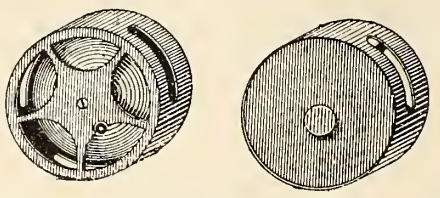


FIG. 2.—APPARATUS FOR PRODUCING THE SOUND.

watch will give us the total of them (the watch strikes the added figures)."

The prestidigitator lays the watch upon a round table, takes a pack of cards and asks the spectator to select one (of course, it is a forced card known in advance by the operator).

"Is it a heart?" (the watch is silent).

"Is it a spade?" (the watch strikes).

"Is it a face card?" (the watch is silent).

"Then it is a small card" (the watch strikes furiously).

"It is useless to try to control you, strike as many times as there are spots" (the watch strikes eight times).

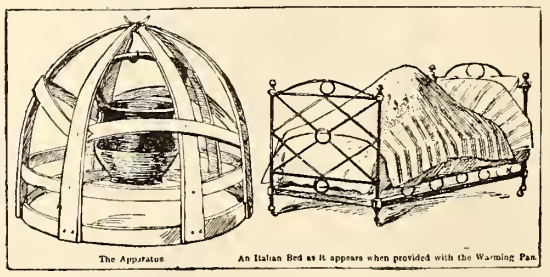
"But here is something better: Tell me who is the most untruthful person present. Is it a lady?" (silence). "Is it a gentleman?" (watch strikes). "A gentleman among the spectators?" (silence). "Could it be me?" (furious striking of the watch). "Take your watch, sir, I have no further use for it."

*Explanation.*—This illusion is due to a little apparatus concealed in the vest pocket. It consists of a small copper box of the diameter of a five franc piece and about three centimeters in thickness. This box contains a small gong in which is placed a clockwork movement that actuates the hammer. This movement, wound up in advance, is capable of sounding about twenty-four times. It is provided with a stop button placed upon the exterior of the box. Upon pressing this button the gong sounds, but ceases to do so when the pressure is removed. This button may be actuated by hand, and it is here that the process employed becomes truly curious: The apparatus being placed in the vest pocket, it suffices to compress the abdomen or distend it in order to have the button, compressed or set free, cause the apparatus to sound or remain mute.—*Le Magasin Pittoresque.*

## ITALIAN METHOD TO KEEP WARM.

IN these days of travel it is hardly necessary to say that the cold of an Italian winter is of a peculiarly searching and trying kind. Until lately charcoal and wood have been the only materials available for cooking and warmth, and English visitors and residents have always grumbled loudly at the discomfort of Italian houses and apartments. Now, however, a great find has been made of two apparently inexhaustible sources of fuel, and possibly later on of gas. About a year ago the Marquis de Genori discovered that his immense estate round the Lake of Massaciuccoli, near Viareggio, was rich in peat, the very existence of which in Tuscany had long been disputed by geologists and experts. No time was lost in turning the discovery to good account; the requisite machinery for production was constructed, and although hand labor only was at first employed, peat (*torba*) in the convenient form of solid blocks of convenient size was for sale last year in Florence and elsewhere at a very low price. It is now becoming popular in Tuscany, and is much sought after, so that if, as is stated in the *Nazione*, the enormous valley of the Maremma and the Pontine Marshes are equally productive, a new industry on a vast scale will shortly be created. It is further stated that gas can be produced from *torba* of so chemically pure a quality as to reduce to a minimum the cost of cleansing gasometers.

The other combustible material which has also been recently "unearthed" is called *lignite*, and is thus described in the dictionary of the *Crusca* Academy: "Wood which having been buried by a convulsion of nature has become carbonized, but without losing its vegetable characteristics." Lignite is in appearance very like slaty coal, and is of considerable weight. It burnt slowly, with little smoke, gives great heat and has no smell. It is found at S. Giovanni, Val d'Arno, Tuscany, and also in the Maremma, and the supply of




HOW TO KEEP WARM IN BED—THE ITALIAN EDITION OF THE WARMING PAN.

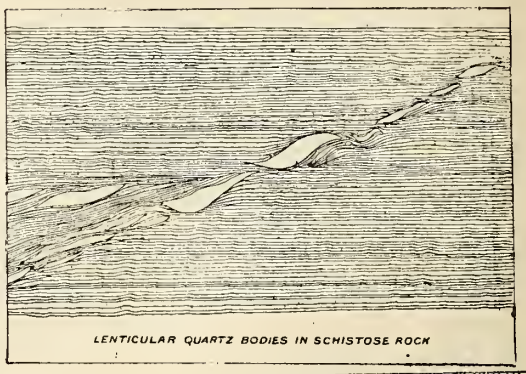
it seems to be unlimited. The mountains around the former place, indeed, appear to be in part built up of it. The manner of extracting it is simple in the extreme. The mountain is tunneled to a certain distance, rails are laid down, and wagons filled with great ease and rapidity. The price of *lignite* is slightly in excess of that of *torba*, but both are infinitely cheaper than any other class of fuel hitherto produced.

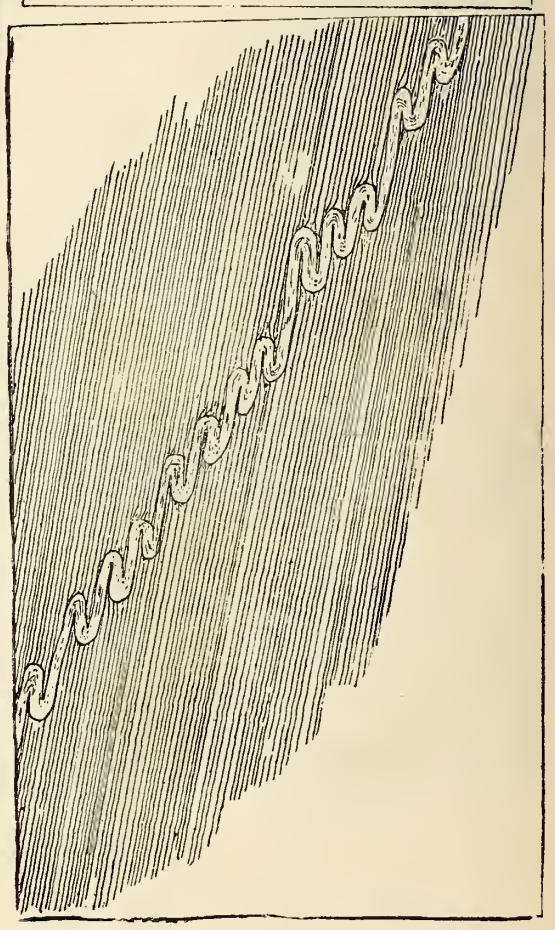
Whatever facilities, however, the Italians may have in the future for keeping themselves warm, it is quite certain their old methods will long survive. No Italian apartment, however humble, is without its *cassette* for the feet. They are oval boxes, generally of brass, with perforated lids, and are filled with *brace*, or small burning charcoal. *Scaldini*, heated in a similar way for warming the hands, are terra cotta baskets of graceful shape, with a circular handle by which they can be carried about; but the quaintest of all appliances is the Italian substitute for the warming pan. It is simply a wooden cage open at the bottom, inside which is swung by a strong wire the earthenware *scaldino*, full of live charcoal. This apparatus is introduced under the bed clothes, and a bed so charged presents at first sight, as will be seen from the sketch, a most startling appearance.—*Daily Graphic.*

## CURIOUS MINERAL FORMATIONS.*

THE Helvetia, like other mines near Julian, San Diego County, occurs in the crystalline schists, the quartz being found as lenses inclosed in the country rock. Some of the lenses might be mistaken for fissures, but I failed to see one possessing the characteristics of a "fissure."

Nearly all the lenses exhibit a tendency to "make" into the hanging wall side of the country rock, the



CURIOUS MINERAL FORMATION.

lenses of quartz following each other in a general direction, but at an angle with the stratification of the schists, and are separate and distinct from each other, being separated at the ends (where they sometimes overlap) by the "leaves," as they may be termed, of the schistose country rock. These lenses were doubtless caused by a compressive stress on the schists, which had a tendency to split them, but was not powerful enough to cause an abrupt fracture. The accompanying sketch may convey an idea of the occurrence of these quartz lenses.

By the accompanying sketch it will be observed that there is a tendency on the part of the quartz lenses to follow a given direction, which lies at a small angle across the strike of the schists, and that these lenses are not connected, but occur independently, though all are the result of the same force which flexed and split the strata.

The Ready Relief, near Banner, has several levels, all of which are connected by winzes and shafts. The huge bunches of quartz have, from their peculiar form, been denominated "rolls," and I know of no better term which would convey a clear idea of their appearance. As a result of close observation made at numerous points in the mine and on the surface at the time of my visit, I formed the conclusion that the "rolls" of the Ready Relief mine simply represent an exaggerated condition of the same sort of flexing of the schists that has produced the other mines of this dis-

* Extract from report of W. H. Storms, Assistant in the Field, in Eleventh Report of State Mineralogist.

trict. The facts as observed lead me to the belief that the "rolls" or folds of the Ready Relief mine, and its extensions, both north and south, are the result of a severe compressive stress upon the schists at right angle to a line running nearly northwest and southeast; that this force was exerted in the form of pressure and not of contraction; that as a result of this pressure there is a tendency exhibited on the part of the contorted strata to form a reverse fault and not a normal one, and that this power expended itself before the rocks were forced to yield to the strain to the extent of fracture, the result being an abrupt crumpling of the schists without disruption.

Along this line of disturbance percolating waters have deposited silica in enormous quantities. The schistose folded masses have been completely metamorphosed, massive quartz replacing the crushed and crumpled crystalline rocks, though the lines of its former schistose structure are in many places preserved.

A sketch of a characteristic section is here reproduced, and it may help the reader to form some conception of this unusual occurrence of gold-bearing quartz. The strike of the country rock is about northwest and southeast, and varies but little from this over a wide area. The rock is, generally speaking, a dark gray, rather close grained, micaceous rock (argillite), having a dip to the east of about 80 degrees. The succession of folds cut across the dip of the schists at an angle of about 45 degrees from the horizon.

It will be noticed that in places several of the rolls lie side by side. Where this occurs the pay shoot is very large. The thickness of the individual rolls varies from a few inches to 5 or 6 feet, and where the folds parallel each other a width of 12 to 20 feet or more is not uncommon. These rolls do not extend longitudinally a great distance, but seem to gradually diminish, being followed by others along the strike of the vein. It seems quite evident that had the stress which produced this folding or crumpling of the schists proceeded much farther an abrupt fracture must have resulted, and the Ready Relief vein would have been a fissure having a dip of about 45 degrees.

## THE HISTORY OF FOOTGEAR.*

AT the beginning of the sixteenth century footgear became completely transformed. From pointed it became as wide as the hand. It no longer covered anything but the toes, and was provided with a small counter for the heel.

Such foot coverings, which bore the significant names of "goose bill" and "bear's foot," formed part of the armor of the knight (Figs. 26 and 27). On the contrary, the soldier, not much preoccupied with the protection of the foot, wore slashed shoes, which, moreover, were in keeping with his costume (Fig. 28).

In the second half of the sixteenth century, the Spanish costume, then the fashion, included anew a pointed shoe that covered the entire foot. It was accompanied with knit silk stockings, a great novelty at this epoch. Northern and Central Italy followed their own inspirations, but Southern Italy, under subjection to Spain, naturally adopted the fashions of its conquerors. Thus, at Naples, there were used shoe supports that were so high that they condemned the ladies to a difficult and uncertain mode of locomotion (Figs. 29 and 30).

It was during the thirty years war that the high footwear or boot (Fig. 31) came into fashion. It was worn by civilians and the military. The ecclesiastics, the commonalty and the peasants alone wore the low shoe. The spurs were fastened above the heel by means of straps that were concealed by a wide piece of leather (Fig. 32). The coxcombs, elegantly dressed, wore turned up boots with the edges ornamented with lace. The boot makers became important persons, and many of them were reckoned among the artists. There resulted a genuine emulation, and, each desiring to surpass the others, magnificent boots were soon seen (Fig. 33). At Paris, the courtiers wore over their top boots galoches that they took off upon entering. At this epoch lace disappeared from the top boots and was worn upon the knees. During this great success of the boot, the shoe was worn scarcely anywhere, except in the country, but it came into great favor again in the Parisian drawing rooms when Louis XIV. no longer led his troops in person upon the field of battle. Fig. 34 shows a shoe of this epoch.

Top boots, still worn by generals, mounted troops and young students, were replaced in 1670 by low shoes provided on the instep with a very stiff and very showy lace bow (Fig. 35). It was also at this epoch that silk stockings were in great favor.

In the eighteenth century, the epoch of antiquated styles, the men wore the buckle shoe (Fig. 36), and the ladies the silk or white satin shoe.

The cavalry of this epoch wore the topless boot, and the infantry wore shoes, stockings and gaiters extending above the knees. A classical example of the high heeled shoe is the embroidered Venetian slipper (Fig. 37). With the advent of the so-called Werther costume (1780), the top boot again came into favor. The men of the Revolution wore it (Fig. 38), as did the *Incroyables* of the time of the Directory (1795–99), while the ladies, rejecting the high heeled footwear, adopted the flat, open shoes with crossed ribbons that were still in fashion during the first thirty years of this century.

After 1820, trousers came into fashion for men, and this naturally led to the shoes free from ornament that are still worn in our day.

We have just reviewed the somewhat lengthy history of footgear, from the Pharaohs down to our time. It only remains for us now to cast a glance at the peculiarities of certain European foot coverings, and to occupy ourselves briefly with the people of the East and with certain tribes of the New World.

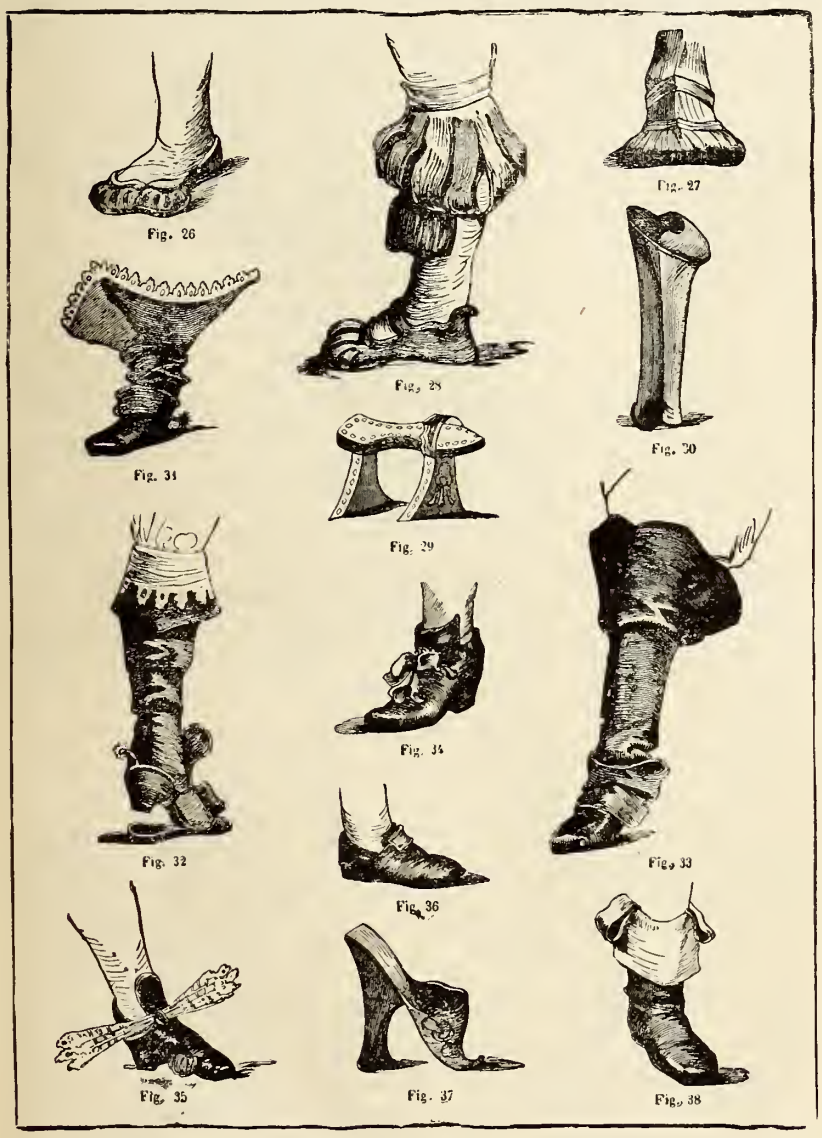
The present shoes of the Italians of the Abruzzos (Fig. 39), as well as those of the peasants of eastern Russia (Fig. 40), recall those of the ancient Germans already described. But they are laced higher and more artistically among the Italians than among the inhabitants of the plains. The reason is simple: The mountaineer needs stronger footgear. The Spanish gaiter shown in Fig. 41 forms a covering for the leg which is both handsome and practical. These gaiters are embroidered and ornamented with lace.

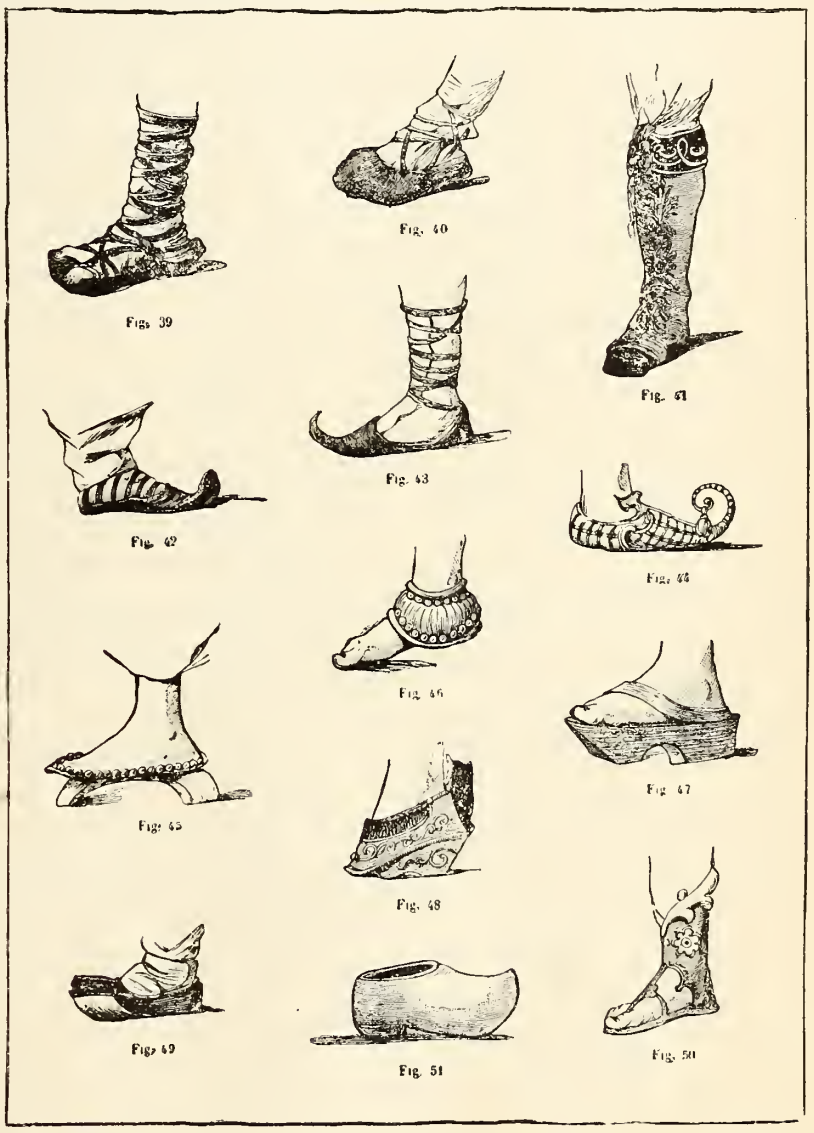
Among the Mohammedans it is customary to take off the shoes upon entering the mosque or a house. The words addressed to Moses, "Remove thy shoes, for the place in which thou art is holy," has still the force of law in the East. We ought not to be surprised, then, that in the Levant, and particularly among the Mohammedans, but little importance is attached to foot coverings.

Among the Turks and Persians, the shoe is low and scarcely covers the toes. The heel is supported by a small counter, and the shoe terminates in a point in the form of an upturned beak (Figs. 42 and 43).

The Hindoos use a different shoe, which recalls both the European and Oriental foot covering. In the country of the Ganges and the Indus we find again the shoe, "a la poulaine," slightly transformed, worn by the princes (Fig. 44), then the wooden sandal for persons obliged to walk in the streets (Fig. 45), and finally the anklet (Fig. 46) worn by young girls.

The Japanese make use only of a wooden sandal. It leaves the foot of its natural form. Among the Chinese, on the contrary, an æsthetic aberration of the mind has led to a horrible distortion of the feet of the women. The shoe (Fig. 48) is naturally in keeping with the form of these mutilated feet. In China, the men wear a shoe whose form recalls that of a boat (Fig. 49). In this country, very little leather is used for the shoe. Its sole is of felt and the top of cloth.




FIGS. 26 AND 27.—Shoes of the Sixteenth Century. FIG. 28.—French Shoe of the same epoch. FIGS. 29 AND 30.—Neapolitan Shoe Supports. FIGS. 31 TO 33.—Military Boot of the Thirty Years War. FIG. 34.—Louis XIV. Shoe. FIG. 35.—Shoe with Lace Bow. FIG. 36.—Buckle Shoe. FIG. 37.—Embroidered Venetian Slipper. FIG. 38.—Boot of the Revolution. FIG. 39.—Shoe of the Peasant of the Abruzzos. FIG. 40.—Shoe of Russian Peasant. FIG. 41.—Spanish Gaiter. FIGS. 42 AND 43.—Turkish and Persian Shoes. FIG. 44.—Shoe of an Indian Prince. FIG. 45.—Hindoo Sandal. FIG. 46.—Anklet of Young Hindoo Woman. FIG. 47.—Japanese Sandal. FIG. 48.—Chinese Shoe. FIG. 49.—Chinese Shoe (man's). FIG. 50.—Aztec Shoe. FIG. 51.—French Sabot.

The Aztecs, a people whose original civilization was crushed by the Spaniards, wore a special foot covering (Fig. 50) that somewhat recalls that of the Greeks.

The sabot or wooden shoe (Fig. 51) used by the French, Belgian and Rhenish peasants constitutes a very peculiar form of footwear designed before everything else to be impermeable. As a general thing it is made of a light wood, poplar, for example, and, as it is before all else a practical foot covering, little attention is paid to its beauty.—*La Science en Famille.*

* Continued from SUPPLEMENT No. 943, p. 15073.

## WHAT WE KNOW OF THE LOBSTER.

By FRED MATHER.

WITHIN the past five years we have learned much of the life history of the common American lobster that is new, the most important item being a discovery of its spawning habits, which will simplify our attempts to hatch this valuable crustacean on a large scale. We knew that the female lobster carried a mass of eggs under her abdomen or "tail," as it is improperly called, and that they hatched there, or that we could hatch them under proper conditions of temperature and density of water, and there our knowledge of lobster propagation ended. There are many other things about the life of the lobster that are not popularly known, and without going into a technical description of its anatomy, we may find much to interest us in its habits, development, mode of reproduction and other incidents, from its emergence from the egg to its capture for market, where we will leave it to the mercies

of the *chef* and the lesser deities who preside over our kitchens.

To begin at the beginning is difficult. It recalls the old problem, "Which was first, the egg or the hen?" But in order to break into the life circle we will begin with a small lobster of a few months old, say in September. The temperature is lowering and no more growth is to be made until next year; therefore a gradual movement toward deeper water is begun in order to be beyond reach of the rapidly cooling waters near shore and to get below the influence of frosts, as the tortoises, frogs and some of our land mammals do. At this time our young lobster will measure from one to two inches, exclusive of the claws, according to the circumstances of food and the date of hatching, the latter being entirely a question of temperature. Living at a depth where there is sufficient warmth to sustain life, but not enough to rouse much of an appetite, our young lobster lives through the winter without making any growth, and in the spring crawls up, as the waters warm, into the shallows and begins to feed on such animal forms, alive or dead, as may come within its reach.

Incased in a hard, unyielding shell which does not grow, it may be compared to a knight in armor, who would be obliged to get a new suit if he should outgrow the old one; therefore, after accumulating a store of material for growth, the shell either splits up the back of the carapace or the latter separates from the first ring or segment of the abdomen and the hinder portion of the animal is withdrawn, and then, with great labor, the forward parts follow and the lobster lies soft and helpless, a toothsome morsel for any predatory fish that may chance along; but instinct teaches the lobster that down among the crevices of the rocks is a sanctuary, and there it remains for several days until the skin hardens into a new shell and it can again fearlessly face its enemies in search of food. It has been my fortune to witness this operation several times while connected with the New York Aquarium, Thirty-fifth Street and Broadway, in 1876-78, and twice since in lobster cars in Vineyard Sound, and it is wonderful what a great increase in size takes place at once after the animal leaves its shell. Another wonder is how the great claws are drawn through the very small joints, one or two of which split lengthwise while others seem to soften and expand enough to permit the passage of the claws. When we realize that the lining of the stomach is attached to and cast with the old shell, it will be seen that the change of armor is a complicated and difficult process, not unattended with danger. The new shell is often to be seen under the old one, and then the lobster is in the same condition as the "shedder" crab, so eagerly bought by salt water anglers for bait, the body being somewhat shrunken from the shell. After casting the shell, the lobster resembles the "soft" crab, which is so esteemed by the epicure that they are sold at many times the price of the "hard" crab. These names apply to the common edible or "blue crab," of the Atlantic coast, at different periods of growth.

There is a singular prejudice among lobstermen against eating a soft lobster which does not extend to epicures. I have eaten of them when soft, and think them excellent; surely, the animal is fat and in prime condition or it would not shed preparatory to taking on greater size. Just how long it may take for the new shell to harden may depend on temperature or other conditions. One in the New York Aquarium, in summer, became quite hard in about twenty hours, and took food the third day after shedding. There seems to be a provision of nature that the female shall not cast her shell until the eggs are hatched, otherwise they would be lost, as they are greedily devoured by eels and other fish. As an instance of this, I will cite the fact that the law of Massachusetts forbids "berried" lobsters to be sent to market. The honest lobsterman, therefore, puts such a lobster in a car which has holes large enough to admit eels, and in twenty-four hours she can be sent to market in compliance with the law, for she will have no eggs left.

I have purposely skipped from the little lobster that we left foraging on his first spring campaign to the habits of the adult, which are the same, because we know nothing of the rate of growth beyond the first season. We know that lobsters shed their shells at irregular times during most of the year, more frequently in the warmer portions, and that this only occurs because the creature is growing and its armor is not large enough. Just how old a marketable lobster of two to ten pounds may be, no man knows, and such knowledge could only be obtained by rearing them in confinement, and then it might not be conclusive under different circumstances of food and temperature, and the casting of the shell forbids marking individuals.

The female spawns but once in two years. Notes made on the eggs of lobsters in the New York Aquarium show that they hatched before July, or when the water reached a temperature of *about* 60° Fah. In 1891 I began the hatching of lobsters for the New York State Fishery Commission, of which I am one of the superintendents, and found that eggs taken from lobsters from the middle to the last of July did not hatch that year. Then it seemed as if the lobster might be a biennial spawner, but I did not dare to say so. A report of my observations sent to Prof. Samuel Garman, of the Museum of Comparative Zoology, Cambridge, Mass., brought a letter dated Aug. 30, 1892, complimenting my studies on the life history of the lobster and inclosing a printed report to the Massachusetts Fish Commission, dated Dec. 17, 1891, in which he shows that his investigations proved that the lobster spawned but once in two years. Therefore, I have solid backing in making the statement that heads this paragraph

Since this I have taken, for the New York Fishery Commission, a large number of lobster eggs and have turned out this year from Cold Spring Harbor, Long Island, 177,000 young lobsters into the waters of Long Island Sound. These were from eggs which otherwise would have been sent to market with the parent and have been boiled and thrown away with the shells, and were therefore just so many saved from destruction, and given a chance to struggle for life. There is no law in the State of New York relating to "berried" lobsters, and from what is said above of the Massachusetts law, it does not seem that one would be advisable, unless so framed that the lobsterman should take the eggs from the lobster and either keep them in a place where they would hatch, or better yet, save them for an agent of the fishery commission who could collect them at intervals, and would reward the lobsterman sufficiently to make him interested to turn in as many good eggs as possible.

The eggs, which, as before said, are carried on the appendages under the abdomen, number fifteen to the linear inch, and measure 6,090 to the fluid ounce, are attached not only to the swimmarets, but also to each other by threads, and are aerated by an almost constant motion of the appendages, and in confinement many eggs are loosened and fall off, perhaps from the habit that the parent has of poking among them with her legs. In the spider crab this poking is not only frequent, but the eggs are eaten by the parent, at least when in confinement, but I have never seen a lobster eat its eggs. It has been said that lobsters spawn at all times of the year. This is not so, for the reason that they are not as active in winter and do not feed as much as in summer, and also because the young do not hatch until the water reaches a temperature of about 60° Fah., which in Long Island Sound might occur after the latter part of May, and in that region the hatching season is over by the middle of July, and as the mother has been feeding while carrying her eggs, she can then shed her shell and begin to develop the so-called "coral" that epicures prize, which will form the eggs to be laid the second year. The fact that female lobsters bearing eggs outside while others have the coral inside are taken in winter supports the theory of biennial spawning. On August 16, 1893, I took a lobster from a car which the owner told me had spawned two days before. The microscope could detect nothing in the eggs, because the yolk filled them entirely. Four days later the yolk had shrunken and the "mulberry" stage could be seen in the clear space, and by the 25th the eye was visible. The eggs are dark when first laid, and grow lighter in color as they develop. From this until October no change was seen. The water growing cooler, the mother did not take as much food as before, but seemed to be as pugnacious as ever, showing fight to any one who approached the glass. At present writing she is living in a tank about 12 × 18 inches and may live all winter.

She had been plugged in the claws to prevent danger in handling, as is usual, but I removed the plugs, and she can now use her claws as well as ever.

When our little lobster comes from the egg an inexperienced eye might easily suppose it to be a young shrimp or any other crustacean, for, unlike its fresh-water prototype, the crawfish, which at hatching resembles its parent in everything but size, the young lobster is in an embryo or larval state, as much so as an embryo trout, which has no resemblance to its parent. It moults perhaps four to six times during the first ten days of its life and makes, according to Prof. S. I. Smith, of Yale, three changes of form in this time before getting the large claws and assuming the shape of its parents. They swim throughout all these changes and perhaps long after, which makes it certain that a plant of young made at a particular spot may be repeated many times without danger of overstocking that locality, for as they swim away the tides and currents scatter them, and when the time comes to settle down to steady habits they are wide apart. Still, as the plantings made by me for the New York Fishery Commission were all made at Cold Spring Harbor, on the south shore of Long Island Sound, some fifteen miles west of the middle of that body of water, the varying tides would not take the little swimmers outside its limits, because the returning tide would bring them back again. Therefore there is no doubt about the value of saving the lobster eggs and planting them in the Sound. Of course, some of the New York lobsters may cross the Sound and be taken in Connecticut traps, just as New York salmon and shad are taken by fishermen of New Jersey, but that is not a thing to be considered seriously.

A very natural question for a reader to ask at this point is: "Why don't you retain the youthful lobster until it ceases to swim and settles down to crawling, and thereby stock a certain district in which your State, that pays for the work, is interested?" To this I should reply that in theory that would be the proper and most correct thing to do, but in practice we find that there is a factor that will not be left out of our calculations, and this factor is cannibalism.

There is, at present writing, no food for a larval lobster known to me that is as acceptable as another larval lobster that has just moulted. I have tried to bribe them by hanging flesh of eel, clam, beef, lobster (adult), blue crab, and fiddler crab, but without avail; their love for their fellows which prompted them to take their brethren in out of the wet, lest they might be devoured by small fishes, baffled my efforts, and there was no resource but to plant the fry as soon as hatched. If each youngster could be placed in a tank or even a small compartment by itself, no doubt it would accept any, or all, of the foods named, but at present we are not prepared to feed a million or more individual lobsters in separate stalls for months before turning them out to shift for themselves. They cannot be reclaimed from cannibalism by any known means. They are fighters by nature, and when a lobsterman has a lot of adults in a floating car and a storm comes up, each lobster blames his neighbor for any collision that may ensue and they engage in a general fight, which is not only disastrous to themselves but to the lobsterman, for lobsters are not marketable in fragments.

The size of marketable lobsters has been on the decrease for the past fifty years. Half a century ago my father never brought home a lobster for family use under six pounds, and it was often twice that weight. One under six pounds was not thought worth picking the meat out of, for the labor is the same, no matter what the size; but to-day a two-pound lobster is considered of good size, although an occasional "deep sea" lobster of twenty pounds, or more, is seen on the stands. These usually have large barnacles, oysters or other animals of good size attached to their shells, showing that they have not moulted in some years, and their claws are always bruised and blunted as additional evidence that their armor has not been recently renewed. The taste for "chicken" lobster has done much in recent years to kill off the young and to prevent their attaining a larger size, but the canneries are credited with taking in all that may be rejected by law. The State of New York had a law that no lobsters measuring less than ten and a half inches, exclusive of claws, should be sold. This excellent law was, I believe, obtained by Mr. Eugene G. Blackford when he was president of the New York Fishery Commission, but was repealed at the instance of State Assemblyman Flinn, who desired to serve chicken lobsters at the free lunch counter in his liquor saloon.

That lobsters of twenty pounds weight have been taken within a few years I know, for I have seen them weighed; but the monsters of twice that weight that we read of are not well authenticated, and the story of the judge who, after the manner of Solomon, decided a bet on the weight of these crustaceans against the man who brought sworn testimony of old fishermen, who remembered lobsters of forty pounds, by saying "affidavits are not lobsters," has passed into history. A century hence, my statement of having seen a twenty pound lobster may be received in the same way, and some judge, yet unborn, may paraphrase the above decision, and solemnly declare that "statements are not lobsters."

A curious thing about a lobster is the difference in its claws. One is thick and blunt and the other is long and slender. One seems to be for crushing hard objects and its mate seems formed to hold them. This is the case with every individual, but there are right-handed and left-handed lobsters. Some years ago Mrs. Mather painted lobsters surrounded by celery, oil, vinegar, and all the necessaries for a mayonaise, but one of the lobsters had the big claw on its left. When allowed to see it, I remarked that there was either a mistake or her specimen was abnormal. She insisted that the original must have been so, and on my next visit to Fulton Market, where over a hundred lobsters were handled for my edification, I found that a lobster might be either right or left handed without violating any rule, and then made my apologies to the artist. The color of lobsters sometimes varies from the ordinary olive-green, with reddish tints on the claws, to red all over, and a mottled coat is quite often seen. The red ones are quite rare, and the few of this color that I have seen have been lighter than the boiled lobster, sometimes with a yellowish cast. The cause of these variations is not known.

The lobster feeds upon animal food exclusively, for its digestive system could not assimilate vegetation. Its stomach is a sac, just behind the mouth, and has no other opening, save the small pores through which the digested portion of chyme or chyle is filtered into the thorax, there being a space of some inches between the stomach and the only intestine, or drain tube, which begins at the first segment of the abdomen and runs without convolution to the cloaca. The stomach is fitted with rough, bony plates to masticate the food, and when opened shows a fanciful figure called "the lady in the chair." All bones and undigested portions are ejected through the mouth. In dressing a lobster for the table, the so-called "poisonous parts" are rejected. They are the stomach, which could not be eaten, and the vein-like intestine spoken of. To remove the latter it is only necessary to split the abdomen, or so-called tail, lengthwise, when it will be seen as a greenish thread. All other parts are eatable, and the tender, green "fat" in the thorax, and the delicate, white "fat" lining its shell, should never be lost, as they contribute both flavor and digestibility to the harder portions.

The lobster does not range far south on our Atlantic coast, because it is sandy south of New Jersey, and does not afford protection for them when in the soft state, even if other conditions were favorable. Large individuals are sometimes taken on the coasts of Delaware and Maryland, and they range as far north as Labrador, the best lobster grounds of the Atlantic being Nova Scotia and Maine. They were formerly abundant in Long Island Sound and about New York harbor, but the pollution of the waters, especially with "sludge acid," from the petroleum works, has driven them away. This abominable stuff does not drift far, but settles on the bottom, and, while it may not disturb the shad and salmon, which are migratory, it kills out the oysters, clams, mussels, snails, and all those forms that live on the bottom, including the lobster, and compels the fishes which seek food in those waters to go elsewhere. The canning of small lobsters in Maine may affect the product there, but the worst of all enemies is man. Of all the destructive agents to animal life of most kinds, man stands at the head, at once the wisest and most ignorant of all animals. His ignorance is especially in contrast with his intelligence, when he deals with other creatures. And the lobsterman is an instance; he wants to see lobsters plenty, because he finds a ready market for all he can get; but, when he raises a lobster pot and finds that two or three small lobsters of four or five inches in length have ventured to eat the whole or part of his bait, he is angry, and, instead of returning them to the water to grow, he mashes them on the bottom of his boat. As well might the farmer shoot his young fowls for eating his grain! The lobster will eat fish, clams, mussels, and other animal food, fresh or stale, but in the pots a fresh bait is more attractive, and the lobstermen use almost all kinds named for bait, and could, with small expense, so make their traps that, when a lobster entered the pot, it could not devour the bait, and so afford to let the young go free if the larger ones did not devour them in the pots.

The power of the lobster to reproduce a leg or claw is well known. It is not done until the next moult, when the new limb appears as a very small model of the original, but after a few changes of shell the claw is restored to its normal size and usefulness. The animal can and does cast a claw when frightened, especially in cold weather, probably to satisfy its captor with a portion instead of the whole—a tub to the whale, as it were. The claw is snapped off with a jerk, as if to say, "Take this and let me go." The lobsterman never lifts the animal by its claws for this reason, but grasps it by the thorax, leaving the large claws to hang down or turn up in a vain attempt to pinch his hand.

Our friend has two means of locomotion. When in danger it can go backward rapidly by means of a few vigorous flaps of its tail, but ordinarily it crawls forward on the bottom, holding its large claws well up. If left in a pool by the receding tide, it would stay there and perish before trying to go overland to the

sea, even if not ten feet away.* When taken from the water the lobster is very helpless. Its specific gravity is great; its enormous claws cannot be lifted in air, and when laid on the market slabs it remains where it is placed from sheer inability to move.

Just how the eggs are impregnated is not known. It is said that the milt is placed near the oviduct some time before the extrusion of the eggs, and that they are fertilized by passing over it. Of this I know nothing, and merely insert this paragraph to show that this question was not overlooked. The sexes of lobsters can easily be distinguished without the presence of eggs, but it is no part of my purpose to enter into the realm of anatomy or theory, as the title of this paper is "What We Know," etc.† When the pairing takes place and how it is performed no man knows. A study of the reproductive organs has developed a theory, and there we stop.

The increase of population has naturally increased the consumption of lobsters, and the great decrease in the size of this crustacean, referred to above, is an evidence that they are slow of growth, and the marketable lobster of to-day, weighing from one to two pounds, may be from four to six years old, possibly more. In all these estimates of weights a fairly plump, well-fed lobster is meant, and not one that would be rejected by the housewife as not worth picking the meat from, for she has learned to weigh them in her hand, and of several of the same size, to choose the heaviest.

We hope to increase the supply of lobsters by saving the eggs from destruction, but the ever-increasing demand for them will prevent their becoming cheaper in the markets.

[FROM THE SUN, NEW YORK.]

## THE HAWAIIAN ISLANDS.

IN the central regions of the northern Pacific is a long and narrow submarine bank, extending about 2,300 miles nearly northwest and southeast. The waters over it are from a few hundred to 6,000 feet in depth. The northern and southern slopes are quite precipitous, sinking abruptly to oceanic depths. Here and there along this bank volcanic vents were opened, in some past age, and the great outpourings of lava were finally lifted above the sea level, adding new islands to the ocean. About sixty of these islands, most of them small, were raised along the bank, and around many of them the polyps lived and died, and their remains are embedded in coral reefs.

The narrowest part of this bank is its eastern end, but, strange to say, on this most inconsiderable portion the largest islands are reared. They form the Hawaiian group, and the greatest of them, Hawaii, is near the extreme eastern end of the bank. An hour or two of steaming from any port on the islands takes a vessel into waters of oceanic depth. A half day's voyage takes the vessel into waters as deep any in the Pacific, except the abysses east of Japan and the Challenger and Miller deeps.

There are eight inhabited Hawaiian Islands, besides five bits of rocky expanse that are hardly large enough to be turned to any account. We observe some very interesting things about these islands. The movement of waters around them is remarkable. The islands lie in the northern edge of the north equatorial current which flows so steadily westward: and a little north of them there is, if not a well defined current, at least a tendency of the wide surface expanse of waters to drift eastward. The result is that flotsam and jetsam, both from America and Asia, find lodgment on the shores of these islands. Pine trees from the coasts of Oregon or Vancouver Island are often stranded on the archipelago. Native traditions have handed down reports of red men from the far east whom some chance cast upon the islands. Men are still living on Oahu who remember when four poor Japanese survivors of a party of nine reached their coast, more dead than alive, and told of the terrible ten months' drift that had carried them thousands of miles over unknown seas. "Now we know we came from Asia," said the Hawaiians, as they recognized the resemblance between these castaways and themselves.

The area of these islands is 6,640 square miles. The largest island, Hawaii, receives a far greater quantity of rain than the other islands, because it lies more directly in range of the windward storms, and yet no streams are found carrying the water to the sea except along the northern coast fringe. The rains disappear quickly through layers of volcanic ashes, reaching the sea by subterranean courses or sinking deep through the strata and turning into steam to add terrible power to the never-resting plutonic forces.

Active volcanoes, the world over, have various claims to distinction. Cotopaxi is the most lofty active volcano. Sangai, also in the Ecuadorian Andes, is the most active. Hawaii has the greatest volcano in the world. The volume of lava pouring out of Mauna Loa has been sufficient in a single eruption to build up another Vesuvius. A little east of Mauna Loa is the volcano of Kilauea, whose oval crater, nine miles in circumference, is the largest active crater known; and then on the neighboring island of Maui is the dead volcano Haleakala, whose crater, covering an area of sixteen square miles, is the largest on the planet as far as we know. These volcanoes, living or extinct, are among the wonders of the world. Every ten days a steamer leaves Honolulu to carry tourists to Mauna Loa. The round trip takes a week, and costs only $50. These volcanic forces, which are still so active on the island of Hawaii, became extinct many ages ago in the more western and smaller islands. Their craters, worn away by ages of denudation, are most of them unrecognizable now. Vegetable mould, mixed with pulverized lava, has covered the once molten lava streams with verdure. Warm springs feebly represent the volcanic phenomena that were once so predominant. Some crater pits, however, are still very noticeable. One of them is the Punch Bowl, seen back of the town as vessels enter Honolulu Harbor, another is the famous Pearl Harbor, a little further west, where vessels may steam right into an ancient crater, through whose broken outer wall the sea pours in.

Somehow or other human beings reached these eight volcanic islands, where they became very numerous. A hundred years ago, probably 200,000 of them lived there. When Captain Cook discovered them in 1772, he estimated their number at 400,000, but this was a great exaggeration. They were then, and their descendants are to-day, the finest specimens of the Polynesian-Malayan race. They are a copper-colored, handsome, well-built, intelligent race, as capable of reaching a high level of civilization as any aborigines who ever enlisted the services of missionaries; but they are still children, and still need the guiding hands that have led them so far.

Living on the northeastern outskirts of the Polynesian world, and without traditions showing that they have held their kindred far south and west of them in remembrance, they speak practically the same language as the natives of the Society Islands. Separated by thousands of miles from New Zealand, they and the people of those islands can understand one another. This is one of the wonders of human migration, and perhaps the world will never know how these widely scattered peoples, who so plainly belong to the same region and family, were so widely wafted over the vast expanse of ocean to find new homes in the islands that are scattered over it.

There is no doubt that long before Cook found the islands the Spaniards knew of their existence. In the early days of maritime discovery, however, the Spaniards were not giving away much geographic information. Cook called the archipelago the Sandwich Islands, after an English nobleman. Much to the delight of the educated natives of to-day, the islands are now very well known by the name of the largest of them. The name Sandwich Islands is likely to fall into complete disuse. It wounds the pride of any intelligent native to hear his country referred to by the name that Captain Cook gave it.

In many natural aspects these islands have changed greatly within a hundred years. The flora and fauna of the little archipelago, nearly 500 miles long, has been greatly enriched by the outside world, and particularly by Auierica. The islands are not naturally so well endowed in these respects as might be supposed from their favorable position and fertility. Cook saw cocoanut and bread fruit trees along the coasts, but vegetation was rather sparse, except in the deep, well-watered valleys. The food products that now form the agricultural riches of the islanders were nearly all introduced by American missionaries. The natives also had few varities of mammals. A hundred years ago the dog, the hog, and the fowl were the only domestic animals. Now horses are in abundance, cattle raising is, in some districts, a profitable industry, and a single American has 75,000 sheep on the most western island of the group. Cattle that escaped to the mountains now live wild and are hunted for sport and food. The natives often dig pitfalls for them, and years ago, newspapers all over the world told of the sad fate of a botanist who went out for scientific study and lost his life by falling into a hole where he was gored to death by a bull that had stumbled in before him.

Great as the change has been in the floral and faunal aspects of the islands, it cannot be compared with the mighty changes in the people themselves. They were in no way superior in ideas and morals to other Pacific island savages when the whites first met them. Polygamy was common. Women were in a condition of inferiority. Infanticide was practiced. Human sacrifices were a feature of idolatrous rites. Cannibalism, to some extent, was in vogue. Such a thing as virtuous womanhood was not known, and there was no word in the language to express it.

To-day there is not a native Hawaiian over seven years of age who cannot read, write and cipher. Education is compulsory. American missionaries made the conquest of the islands. They went to the barbarous people seventy-three years ago, and in a few years not a vestige of faith in the old heathen beliefs remained. Protestantism, mostly of the Congregational type, is the religion of more than half the natives. There is, however, the widest religious tolerance. The Chinese worship in their joss houses. French Catholic priests have been active. They have a following of 20,000 people, over half of whom are Portuguese immigrants, who have flocked to the islands in large numbers. The natives are quite hardy and fairly industrious, but after all they are pleasure-loving, easy-going Polynesians, with little of the moral stamina and perseverance that mark the stronger races. They are not fitted for self-government, and a pathetic fate awaits them.

In spite of better food, clothing, and habitations, they are dying out. The sad fact seems to be beyond remedy. In fifty years more there will probably be few pure bloods on the islands. There is and will continue to he a large admixture of the Hawaiian and other races. The number of men greatly exceeds that of the women—an anomalous condition, for women the world over are usually in the majority.

The curse of the islands is leprosy, which was introduced by Chinese immigrants in 1848. To day about one native in fifty is afflicted with the malady. A large part of Molokai Island is reserved for these unfortunates, 800 in number, whose unhappy fate it is to be severed from their homes and friends until death relieves their sufferings. Years ago the government placed a strong, healthy man, who had been condemned to death for murder, among the exiles of the leper colony, telling him that, if he did not contract the disease within a certain time, he would be pardoned. Many of the people had protested that leprosy was not infectious, and that it was a needless cruelty to isolate the sufferers; but it was not long before the strong man became a hopeless leper himself. Since his death there has been no question that it was wise to maintain the leper colony.

In 1889 there were 92,050 people in the eight Hawaiian Islands. Less than half of this number, or 42,500, were native Hawaiians or mixed breeds. All the others, except 500 natives of other Pacific islands, were Americans, Europeans and Asiatics. It may surprise some people to know that of the 19,000 whites whose homes are in these islands fully two-thirds are Portuguese. The dwindling of the native populace and the great development of sugar growing and other industries made it necessary to procure more labor than even the Chinese and Japanese, who were coming by thousands, could supply. One day the happy thought occurred to an American that it might pay to invite natives of the crowded Azores to go to Hawaii. About 270,000 people live in these little Atlantic islands. Many of them were not averse to trying their fortunes on the other side of the world, where, it happens, they have found in their new homes, at the end of an 8,000 miles journey, almost the same soil, products and climatic conditions as those to which they had been accustomed all their lives. They make honest, faithful laborers, and are so well pleased with their prospects in the few Hawaiian towns and on the sugar plantations that they keep sending for their friends; and so it happens that although the natives are decreasing at the rate of about 1,000 a year, the population of the islands shows a handsome growth at every recurring census. There were 18,150 white people in the islands in 1889, of whom 3,000 were Americans. Our nationality outnumbers the representatives of all the European nations put together except Portugal.

The country has only a few important towns, and Honolulu, with its 25,000 people, is the metropolis of the western Polynesian world. It was an American skipper who discovered the harbor that has made the port of Honolulu what it is. Good harbors are few and far between in these islands. There is hardly a respectable harbor except at Hilo in Hawaii, and Honolulu and Pearl harbors in Oahu. The coasts rarely have deep indentations. Wherever a settlement is on the coasts, a fair anchorage or roadstead is usually found. Many of these little settlements are seen along the shores of Hawaii, but they are nearly all hamlets, containing only a few houses and a shop or two. The only town of much importance in the whole island is Hilo, and a fine settlement has grown up on the shores of the little bay. Hilo has about 6,000 inhabitants, and its importance will gradually increase if the lava streams from Mauna Loa continue to stop short of the settlement. Lahaina, on the south side of the island of Maui, has a roomy and sheltered roadstead, and the houses of its 4,000 people are half hidden among groves of cocoanut and other tropical trees. Another town, Wailuku, of about the same population, but commercially more important, is on the north side of the island. Foreigners live in both these towns, which derive their importance chiefly from the sugar plantations.

The best anchorage in the island of Kauai gave rise to another town of some importance, Waimea, which has the distinction of being built on the banks of a river that can be navigated for nearly a mile, about the only internal navigation in the islands. It is on Kauai that the famous singing sands are found, and scientific men have traveled all the way from this country to discover the secret of their sonority. It was found, when the grains of sand were examined with a microscope, that they contain cavities, and it is supposed that these minute hollows are the cause of the resonance, for when the sand is wet the noises are not heard.

Oahu is the spot that nature has most favored. Fringing its northeast side is a range of mountains whose summits catch most of the precipitation and send it in torrents down the slopes to water the plain that forms most of the island. The east side of the mountains is comparatively dry and barren. The west side and the great plain at the foot is brilliant with sub-tropical verdure and one of the garden spots of the world. Lower hills also border the western coast of Oahu. A broken coral reef surrounds the larger part of the island, and this reef helps to make the fine natural harbor of Honolulu. Here all the comforts and most of the luxuries of life may be obtained. Daily newspapers, good schools, a college, an excellent library, street cars, and electric lights are among the advantages. There is a good deal of wealth in the town, most of it in the hands of American settlers. The society is refined and cultivated. A more delightful place of residence could hardly be imagined. There are few uncomfortable days; the mean annual temperature is that of the more pleasant parts of Florida, and the climate is very healthful. Far and wide over the undulating plain of Oahu are the big sugar plantations, and sugar and rice are also extensively grown on some of the other islands. They are the chief industries, and there is still room to greatly expand them. Coffee, hides, bananas, and wool are next in importance in the exports of the islands.

The United States has done far more than all the other nations combined to make the Hawaiian Islands what they are. No wonder that they excited our early and persistent interest. They form the nearest approach to America of the Polynesian island world. We can reach them in a week, but they are three and four weeks' distant from all other great nations. Our missionaries were the pioneers of civilization. In proportion to its size, no part of the world, reclaimed by civilizing influences, has had so much written about it and for it; and four-fifths of this literature is the product of American pens. Our missionaries have lived there seventy-three years, and their children and grandchildren are to-day among the most prosperous and influential residents. Not a few names of men now known as active in the revolutionary movement have figured most prominently in Hawaiian history. Their families for many years have been wholly devoted to various phases of progress, and we now see them committed to the cause of insuring good government. This is the only blessing the islands need to give them stable and increasing prosperity. It is interesting to trace the ways in which these families have been identified with the good of Hawaii. Mr. Dole, for instance, is at the head of the present Provisional Government. It was an earlier Mr. Dole who, as one of the side issues of his work, made comprehensive studies on the zoology of the islands, and published the result.

The Americans control most of the Hawaiian trade. In 1884, 239 ships entered the port of Honolulu. Of these 191 were North American, 29 British, 4 French, 4 German, and the others were engaged in the Hawaiian local trade. Since then the fleet trading with Hawaii has been considerably increased and the same proportions are maintained. The fostering care of our government has wonderfully developed Hawaiian trade and industry, and our reciprocal treaty give us practically a monopoly of Hawaiian commerce. Our teachers have fostered Hawaiian education; and in 1878 the Universal Exposition of Paris awarded to the islands

* See Eighth Report New York Fish Commission, 1875, page 23, tenth to eighth lines from bottom.

† See "Fisheries Industries," section 1, pages 795, 809.

the Grand Prix for best results in the development of primary instruction.

It is American money and protection that has advanced the culture of sugar and rice by leaps and bounds, that has built the sixty miles of railroad, and spread the telegraph everywhere. Ninety-one per cent. of Hawaiian external commerce is with this country. The schools are modeled after ours. The school books are American. Our gold and silver coins, together with Hawaiian coins, are the only legal tender. Our measures and money are those of the Hawaiian people. Our government determined latitudes and gravity for the Hawaiian government and published the results. An American owns the whole of one of the eight islands, Niihau, and raises many thousands of sheep and cattle there. Another wealthy American, C. R. Bishop, who owned about one-half of Molokai and had his land well stocked with cattle, sheep, and horses, has just made a splendid gift to the people, having transferred this entire property in trust, the income from it to be devoted to educational purposes.

"The Hawaiian Islands," wrote the geographer Reclus, in 1889, "are really a province of the American republic." As a matter of fact, most of the potentialities of these islands are yet undeveloped. The people themselves and the outside world have only just begun to tap their resources. American self-sacrifice, energy, and capital have done what has been done, and all Americans have reason to be proud of the results their compatriots have achieved in seventy-three years.

## DUST AND ATMOSPHERIC PHENOMENA.

By Dr. J. G. MCPHERSON, F.R.S.E., Lecturer on Meteorology in the University of St. Andrews.

AT a recent meeting of the Royal Society of Edinburgh Mr. John Aitken read a most interesting and important paper on "Dust and Atmospheric Phenomena." It was a continuation of the investigations made in 1889, which I abridged in these columns in October, 1890. During 1890 he went over the same ground under different atmospheric conditions. He first visited Hyeres, where by his famous instrument he counted 250,000 dust particles in a cubic inch of the air, whereas on the former visit he counted only 12,000. He observed, however, that where there was least dust the air was very clear, whereas with the maximum of dust there was a very thick haze.

At Mentone, the number of dust particles in the cubic inch was 13,000 when the wind was blowing from the mountains, but increased to 430,000 when the wind was blowing from the populous town, where the air was more polluted. At Bellagio the result was similar. With the smaller number the air was clear and brilliant, with scarcely any perceptible haze on the hills; but with the larger number there was a thick haze, the distant hills being quite invisible. After a series of observations there, with careful examination of the temperature by wet bulb as well as dry bulb thermometer, he came to the conclusion that the increase in the number of dust particles accompanied by constant humidity is accompanied by a decrease in transparency; and that the increase in humidity is also accompanied by decrease in transparency, if the number of dust particles remains constant.

When Mr. Aitken first visited the Rigi Kulm, in Switzerland, the air was remarkably clear and brilliant, and the number of dust particles per cubic inch never exceeded 33,000. On his second visit, in May, 1890, he counted no less than 166,000—about five times the number; this was accompanied by a thick haze, which rendered the lower Alps scarcely visible. The thickness was not due to humidity, for the wet bulb was depressed 10°, therefore the air was very dry; but it was due to the number of dust particles suspended in the atmosphere. On looking down from the mountain to the valleys the air was, some time before sunset, so thick that the lower slopes of Pilatus were scarcely to be detected. This was due to a thick haze between the observer and the mountains, as if a veil were hung between him and the distant scenery. The upper limit of the haze was well defined, and though the sky was cloudless, the sun looked like a harvest moon and required no eagle's eye to keep fixed on it.

Next day there was a violent thunderstorm, which gave an opportunity of making observations at its different stages. At noon, when it was clear, the number of particles to the cubic inch was 66,000. At 6 P. M. the storm commenced and 60,000 to the inch were registered; but in the middle of the storm he counted only 13,000. There was a heavy fall of hail at this time, and Mr. Aitken accounts for the diminution of dust particles by the downrush of purer upper air which displaced the contaminated lower air. For the year before he observed the same change during a heavy fall of rain on the Eiffel Tower, when the number per cubic inch was as low as 3,000.

He next showed, from a reference to the general circulation of the wind over Switzerland during the periods of observation, that when the number of particles was small during his first visit the general air circulation was from the Alps; and, on the second visit, when the number was great, the movement of the air was from the inhabited parts. He also found that on the day of the storm the diminution of the number of particles was concurrent with a change in the direction of circulation, which brought pure air from the Alpine region, and it was when the pure air and the foul air began to mix that the storm broke.

But the most remarkable set of observations was made on the Lake of Lucerne. In the course of an hour there was an exceptional diminution in the number, which made him think that something had gone wrong with his instrument. At 3 P. M. he counted 171,000 in a cubic inch; at 3:45 the number was reduced to 28,000. During the interval the thermometer had risen from 71° to 75°, and the wet bulb depression varied from 11° to 19°. On looking about he found that the direction of the wind had changed, bringing down the purer upper air to the place of observation. The rapid change in the direction of the lower current of air was caused by a southwest wind striking the face of the mountain, which was there nearly vertical.

The bending downward of the trees by the strong wind showed that it was coming from the upper air. At 4 P. M. the thermometer fell to 68°, and the wet bulb depression was 10°; he counted 204,000 particles in the cubic inch—a most remarkable result—but the old conditions were restored by the reversal of the wind.

Returning to Scotland, Mr. Aitken continued his observations at Ben Nevis and at Kingairloch, opposite Appin, Mr. Rankin using the instrument at the top of the mountain. These observations showed in general that on the Ben southerly, southeasterly and easterly winds were more impregnated with dust particles, sometimes containing 123,000 per cubic inch.

Northerly winds brought pure air. The observations at Kingairloch showed a certain parallelism to those on the summit of the mountain. With a northwesterly wind the particles reached the low number of 300 per cubic inch, the lowest recorded at any low-level station.

The general deductions made by Mr. Aitken from his numerous observations during the two years are, that air coming from inhabited districts is always impure; dust is carried by the wind to enormous distances; dust rises to the tops of mountains during the day; with much dust there is much haze; high humidity causes great thickness of the atmosphere if accompanied by a great amount of dust, whereas there is no evidence that humidity alone has any effect in producing thickness; there is generally a high amount of dust with high temperature and a low amount of dust with low temperature, and a high amount of dust reduces the transparency of the air.—*Knowledge.*

## VENUS AND HER CRESCENT.

PROF. R. W. PRENTISS, professor of astronomy in Rutgers College, New Brunswick, N. J., comments as follows in the New York *Herald* on the unusual spectacle which the twilight sky now affords of the exceedingly bright evening stars Jupiter and Venus. He said:

"The phenomenon occurs at intervals of eight years, whenever the planet is at or near its greatest north latitude, and about four or five weeks before inferior conjunction, at which Venus is between us and the sun. Venus is now 33,000,000 miles distant from the earth, but by February 16, at inferior conjunction, this will have diminished to 25,440,000. Venus will then present to us a face entirely unilluminated, and will be lost in the brightest rays of the sun. Even now in the telescope it is seen to exhibit the form of a delicate crescent like the new moon and the quarter part of its disk being in the shadow, so that the brightness seems the more wonderful. After February 16 it will pass to the outer side of the sun, being visible in the early dawn as a morning star, and by November 29 its distance will have increased to 159,000,000 miles, when its brightness will be five times less than it is now.

"Jupiter, although separated from us by more than four hundred million miles, is yet the largest planet in the solar system and exceeds in size a thousand earths. It is the giant planet, and outshines the other stars in outline, in magnitude and luster. Venus, on the other hand, is about the same size as our own globe. Its orbit is almost a circle entirely within the orbit of the earth, so that at times it is between us and the sun, and at other times beyond the sun, its distance varying from twenty-five to one-hundred and sixty millions of miles.

"At present Venus is our nearest neighbor among the planets, and its nearness and high reflecting powers combine to make it most conspicuous. In fact, it is so brilliant it may be seen in a clear sky with the naked eye throughout the entire day by any one who knows just where to look for it.

"It is a little more than two hours behind the sun and a few degrees higher, and therefore may be found a little above the place the sun occupied in the sky two hours before. A few moments after two o'clock every day this week it will be on the meridian, half way up the sky, between the zenith and the south point of the horizon. In the morning hours, from ten to twelve, it is in the southeast at an altitude of about thirty-five to forty degrees.

"It is related by Arago that Napoleon Bonaparte, upon repairing to the Luxembourg when the Directory was about to give him a fete, was very much surprised at seeing the multitude which was collected in the Rue de Touron pay more attention to the region of the heavens situated above the palace than to his person or to the brilliant staff which accompanied him. He inquired the cause, and learned that these curious persons were observing with astonishment, although it was noon, a star which they supposed to be that of the conqueror of Italy, an allusion to which the illustrious general did not seem indifferent when he himself with his piercing eyes remarked the radiant body. The star in question was no other than Venus. Other instances of its observation in the daytime are recorded, some at a very early period—398 A. D., 984, 1008, 1014, 1715 and 1750."

## AN EXPERIMENT WITH THE SCOURING RUSH.

THE scouring rush (*Equisetum hiemale*) is an interesting plant which has been put to practical use. In olden times its hollow, flinty stems were in great repute for kitchen cleaning purposes. The stems are hollow and easily separated at the joints. If one would satisfy himself as to the peculiar property which first suggested the use of this rush for scouring purposes, he has only to draw a joint across the edge of his teeth to find it like a file. William Hamilton Gibson shows us, moreover, in "Sharp Eyes," a way to a pretty chemical experiment with it.

If we take a small vial of nitric acid and immerse any ordinary leaf therein, we shall quickly see it dissolve, literally eaten up by the acid. But what does the scouring rush do under such circumstances?

Immediately upon its introduction into the acid the sizzling process begins, the green pulp of the stem is gradually consumed, the tube, however, still retaining its shape, becoming paler and paler in color, until after a few hours, our specimen is transformed into a pure white alabaster-like column which defies any further attack from the acid.

Upon taking it from the vial and washing it carefully in running water, we hold in our hands a beautiful tube of pure, glassy flint, or silex, an object of great microscopic beauty of construction. Our scouring rush is no longer a vegetable, but a mineral, and in observing its skeleton of stone we easily understand the secret of its utility as a scouring brush.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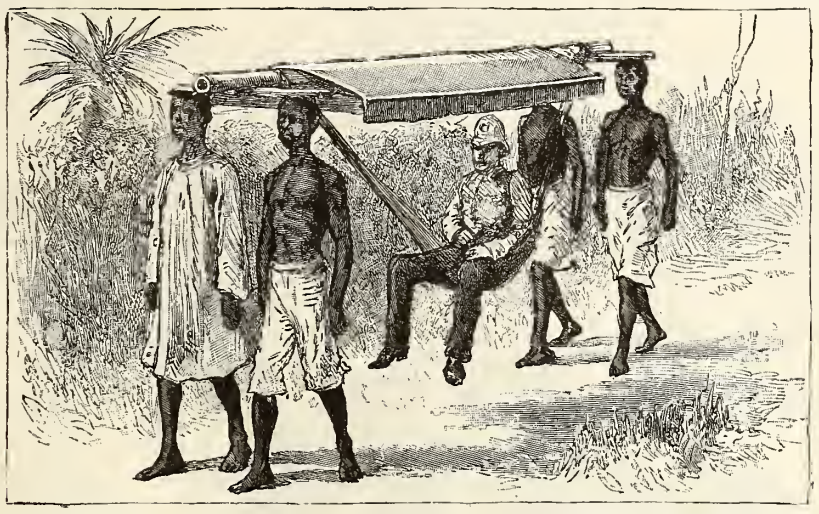
## LIFE ON THE WEST COAST OF AFRICA.

By an Officer of the West India Regiment.

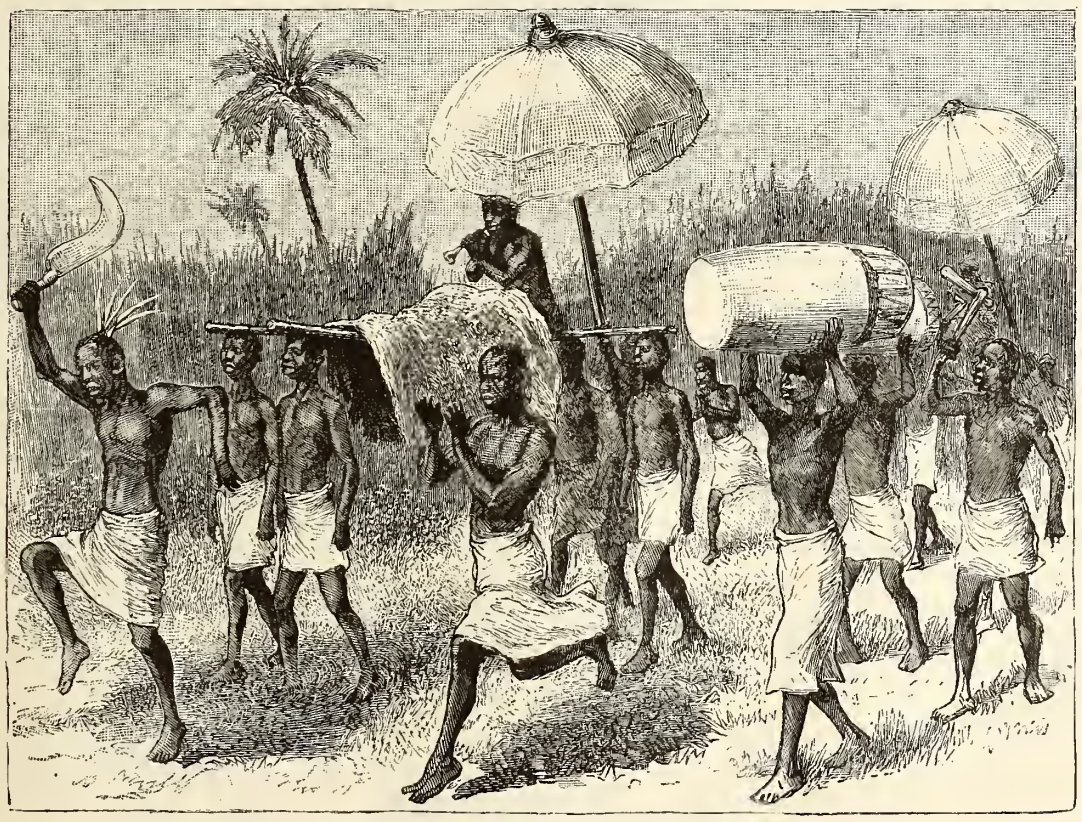
Monotony of barrack life may be said to reach its climax at Sierra Leone, West Africa. Here there are none of the ordinary amusements of a foreign station, such as gymkhanas, polo matches, dances (except dignity balls, with the ladies of color) to brush away the barrack yard cobwebs from the weary subaltern's eyes. However, each officer has to put in a year's service on the coast before he is entitled to his leave, so he sets to work to make himself as comfortable as possible, and to get as much fun out of the place as he can. One takes to photography, another to collecting butterflies (and right well are his labors repaid, for there is no better place in the world for the entomologist than Sierra Leone). Sometimes the naturalist and collector comes out so strong in the subaltern that he will walk these regions for miles with a butterfly net and attendant "boy." It is interesting to note the function this "boy" plays in the economy of butterfly collecting. I have invariably noticed that the entertainment eventually takes the form of the subaltern sitting in a shady spot near the luncheon basket, while the "boy" gathers the flies. Then, again, a four can always be got together for lawn tennis in the cool of the evening; then there are bachelors' picnics on Sundays some seven miles out from Sierra Leone, where cold chickens, potted meats, and lager beer are consumed under the grateful shadow of lofty rocks with the cooling waterfall splashing at your feet. Afterward the pipe and inevitable sleep. Sierra Leone is a most picturesque place as viewed from the harbor; the town, with its white houses gradually sloping up to Tower Hill Barracks, where the West India regiment is stationed, the lofty mountains in the distance covered with dense vegetation form a most pleasing picture, especially from the stern of the ship when you are homeward bound, as a friend of mine remarked.

The colony of Sierra Leone or Lion's Back (called from the shape of the mountains) was originally discovered and named by the Portuguese in the fifteenth century. They were driven out by the Dutch, after whom came the French; it was used by all these nations as a depot for slaves, and an old slave tower, now used for a reservoir, may be seen at Tower Hill barracks. For the next two hundred years the town was periodically ransacked and burned by English pirates. A free colony was established by the English in 1787, consisting of a few hundred freed slaves and a few whites. Freetown was built in 1791, the colony being now in the hands of a company. It was surrendered to the crown in 1808.

From November to April the weather is all that can be desired—bright, sunny days, with cloudless, blue sky and clear, moonlight nights; and in January comes the harmatan (a cool, drying wind from across the Sahara), drying up everything, cracking the furniture and filling your tent with dust; but it is cool, and that is something. The tornadoes are the heralds of the rainy season. They come on very suddenly, and last two or three hours, being accompanied with a strong wind, tremendous peals of thunder, and vivid lightning. And woe betide your quarters if the jahnsies happen to be left open. The rains come down in May, and last until October; then farewell to all excursions, for a wet skin is the usual result of wandering too far from home during the rainy season—and rain it does then, sixty-two inches of rain being registered in one month.



THE OFFICIAL MEANS OF LOCOMOTION IS THE HAMMOCK.



CARRYING A CHIEF TO A PALAVER.

THE SECOND WEST INDIA REGIMENT EMBARKING FOR SIERRA LEONE IN A SURF BOAT.

The shooting is very indifferent, and accompanied with much weariness of the flesh; to tramp for miles up and down hill over heavy ground and through dense bush, with creepers coiling round your neck and threatening to strangle you every minute, in a damp and exhausting climate, to return home after four hours of this with an empty bag, generally damps the keenest of sportsmen after a very few trials. Bushfowl, a kind of partridge, is the only game to be found, and these are very few and far between. No one seems yet to have discovered why horses will not thrive in Sierra Leone; but there the fact remains. Over and over again they have been tried, but only to die; of course, there are a few exceptions. Whether it is the want of good fodder or the malarial influence of the climate, no one seems to know.

In Sierra Leone there were in the whole district just about three ponies—I don't think I exaggerate, but there may only have been two. We subalterns used to look upon them with covetous eyes. One morning, when we were encamped on the heights, hearing a wild shouting and whooping, we rushed out of our tents, only to behold a Mandingo native riding a long-tailed horse into camp, thrashing him at a gallop through the entanglements of tent ropes, regardless of all expense. The steed was eventually pulled up, and the long-robed rider rolled off and offered his mount for sale. A greater sensation could not have been aroused by the appearance of the lord mayor in gala dress. Every subaltern with anything like an equestrian reputation then put on his most "horsey" air, and examined the prize with much wisdom and pursing of lip. The most practical "sub" mounted and tried him at a fence, but returned with a poor opinion of the leaping capacity of West African thoroughbreds; and it *was* a thoroughbred—the man said so himself. Whether it were lineally descended from Mahomet, or he was only calling Mahomet to witness, it was difficult to say; but we gathered that it was incontestably quite thoroughbred. Horses, as a matter of fact, are most plentiful on the healthy uplands of the interior; but in the deadly forest strip along the coast (which seems to be the only part of the country we care to have) the poor brutes cannot live.

The official and recognized and most comfortable means of locomotion is the "hammock"—simply a hammock slung on

a pole and covered with an awning and carried by four bearers. It looks a very heavy burden for four men to carry for miles; but I once, on getting out to stretch my cramped limbs, made the head "boy" get in, which he did with much giggling and laughing, and I took his place for a few hundred yards, and was surprised to find how easy the burden was and how little one felt the weight on the head. I should like to have tried a mile of it, but the hammock "boys" were threatened with hysterical convulsions, and I had to give in. They have such a ludicrously keen sense of humor, have hammock boys.

On the west coast there is seen, besides the hammock, as a means of locomotion for Europeans travel-

A NATIVE GIRLS' DANCE, SIERRA LEONE.

ing, an adaptation of the *jinrikshaw*. It is a most comfortable means of conveyance.

The natives seem always to be dancing—all night long at Sierra Leone there comes floating up to the heights from the flats below the muffled distant throbbing of drums and beat of "clackers" telling of the women dancing.

A thousand miles down the coast is Cape Coast Castle, which, until quite recently, was a military station and occupied by a detachment of the West India regiment. Cape Coast Castle, it will be remembered, was the base of operations in the Ashantee war; the castle is a fine old building, erected by the Dutch or possibly Portuguese. The walls are very thick, and evidently show that labor was cheap in those days. Under the court-yard within the castle walls lie buried the remains of the poetess, L. E. L., who died in 1838, her husband being the governor of the colony at that time. The castle must have been strongly fortified for those times, and fully capable of resisting the invasions of pirates, as the old guns have a good command of the only practical landing place; heavy surfs are frequent all down the coast and make the landing very dangerous. The native crews are very skillful with their paddles, and manage to get through somehow; but many lives have been lost by the capsizing of the boats.

The town is a very quaint-looking place, principally composed of mud huts with flat roofs, interspersed with a few strongly built old Dutch houses—the mud or "suish" houses frequently come down with a run when there is an extra downpour of rain; then, in the most philosophical manner, out come the family of three or four generations and proceed to build it up again, each according to his own idea of architecture—the aged grandfather and the toddling infant each lending a hand. The natives here are Fantis and Haussas. Civilization has not made such strides here as in Sierra Leone in the way of tall hats and black coats, but still the native, who all the week is clad in the simple country cloth and walks about barefooted, thinks it indicative of respectability to don European clothes and boots on Sunday and with a tin-mounted stick and green tassel to promenade the streets; but he does not somehow seem altogether at home, and with Shakespeare might exclaim, "Uneasy lies the head that wears a crown," or a hat.

The imperial troops were withdrawn from Cape Coast Castle a short time since, and the station is now garrisoned by the Haussas, a native force under the Colonial Government and officered by Europeans.

Palavers are very frequent in Cape Coast. The chiefs come down arrayed in all their glory, with the inevitable umbrella held over them by a slave. The umbrella is a very gaudy affair, all the colors of the rainbow, and is more a badge of rank than a protection to the swarthy features of the chief. Each chief is accompanied by his band of tom-toms and reeds. Out of these instruments no apparent tune is produced, but a deafening din rather like the noise of some of Haydn's demons. Trade gin is in great request at these palavers.

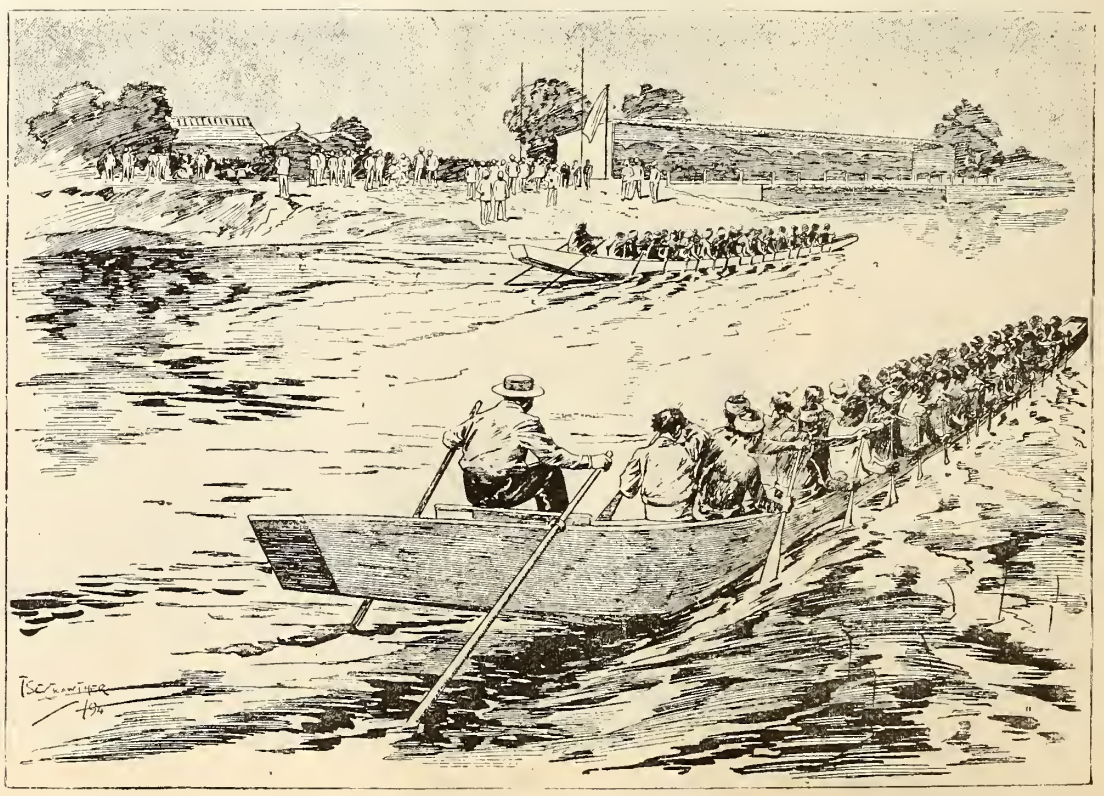
Sierra Leone has one crow over Cape Coast, for whereas the one has three horses, the other can only boast of one—one solitary, hopeless, lonely, lank "gee." Poor solitary beast! The neighings of his fellows, the frolics and racketings and horseplay of his own kind unknown to his stunted intellect—only to munch the repulsive grass for a few moons and then to die! Yet he has much food for reflection. He sees kings—kings are as thick as squires in Ireland or princes in Russia; he sees kings come and go and thinks nothing of it. He hears their "tom-tomming" and "tootling," and he wonders, perhaps, why all this royalty, with its barbaric pomp and its white rods and black rods and gold axes and its leaping, whooping attendants, should be so much in awe of a few white men with nothing to back them but a handful of gayly tailored zouaves—these curious white fellows who come from the sea across the swishing surf and land from the surf boats as if creation were specially designed for them. But his intellect there deserts him. Only one fact remains: *he* can see hosts of kings; but may *they* only see one horse.

The religious creeds all down the west coast of Africa are many and varied. A great number belong to the Mahometan faith, including the Haussas. In all the native creeds fetish largely prevails, and no native is safe from the curses of the medicine man, which curse is generally fulfilled, as the unfortunate victim has poison put into his food or drink; but, of course, that is the work of a devil. However, this superstition has a deterrent effect on a good many crimes, especially thieving.—*The Graphic, London.*

## BOAT RACING IN BURMA.

MANDALAY has been quite *en fete* for three days during the Viceroy's visit. He was received by a large concourse of people, and the whole of the official staff, civil and military, under a "pandal," or covered shed made of bamboos and paper, with cloth here and there. Upon the paper and cloth were painted some curious and wonderful Burmese devices and figures, which shone out brilliantly in the sun. After this gorgeous reception the Viceroy proceeded to Government House, which is situated on the ramparts at the north end of Fort Dufferin. The north gate of the fort was for the occasion cleverly utilized as a stairway and reception room.

One afternoon was devoted to Burmese water sports and boat racing. Out of six entries four were dead heats, and the excitement was kept up by loud plaudits among the crowd, for the Burmese are keen spectators of all sports. The boats are simply long shells of boards bent up at the ends. Each boat is propelled by thirty-two men as paddlers and a coxswain, as shown.—*Daily Graphic, London.*



A NATIVE BURMESE BOAT RACE AT MANDALAY.—FROM AN INSTANTANEOUS PHOTOGRAPH.

## VANILLA.*

By CHARLES E. HIRES.

THE importance of vanilla bean, and consequently the value of the subject of which I am about to speak, cannot be more correctly estimated than by a brief glance at its importance and value as a factor in the commercial products of this country.

To the majority of men the use of vanilla bean is limited to a flavoring extract for ice cream or to add a delicacy and piquancy to an after-dinner dessert; but to the specialist, familiar with its use, it assumes a magnitude that is really astonishing. In the year 1892 in this country alone there was imported and consumed in the various industries and agencies requiring vanilla over one million dollars' worth of this product, numbering over fifteen million beans, and employing in operations of raising, picking, curing, packing and shipping over 35,000 people, constituting in value, in commercial importance, in capital involved in its production and in the amount of labor required for its development, one of the most important products of this vast and rich country.

The vanilla bean is indigenous to the soil of Mexico. The chief center of its cultivation is the state of Vera Cruz, and the metropolis of the vanilla district is the city of Papantla. After twenty years of active experience in handling vanilla, after a long and careful study of it as an article of commerce, and an intimate acquaintance of its various uses, and its growing value as an article of import, I became possessed with a desire to see it in its natural state, to ride beneath the forests where it grew, to pluck it by my own hands from its natural branch; to enjoy its sweet and delicious aroma in the land of its birth, and in general to familiarize myself with the growth and preparation of this wonderful product, which is so rapidly growing in favor as one of our 19th century luxuries.

Take down your map of Mexico and locate the city of Vera Cruz, in the state of Vera Cruz, situated on the western shore of the Bay of Campeche. Go north from Vera Cruz a distance of some three hundred miles to Tuxpan. Equip yourself there with a retinue of mustangs, servants, guide and interpreter, and start to the southwest on a three days' journey, over mountains, through impenetrable forests, over dangerous and treacherous morasses, and through tropical jungles to the city of Papantla, situated about seventy-five miles from the coast, inaccessible by railroad or water, and in the heart of a wild and as lawless a country as you would care to visit, and you have reached the heart of the vanilla growing district; only a few hundred miles by actual measurement, but requiring more time, toil, privation and danger than to make a trip to the Orient. The journey southward was one to me of absorbing interest and constant danger. Its strange inhabitants, its peculiar customs, its striking scenery, and its topographical and geographical features were so impressed upon me by my journey, that I know my audience will pardon a brief and hurried description of some of its most salient features as we pass on our southern march to the home of the vanilla bean.

Actuated by the desire before mentioned, I left Philadelphia on January 31, 1893, on a bright, clear, cool but pleasant Monday. Next day in the State of Indiana we struck a blizzard, with the thermometer down to zero; reaching St. Louis, we encountered the worst snow storm of the season, with the thermometer below zero, and the cars impossible to keep warm. Leaving St. Louis at eight o'clock in the evening, we journeyed southward and the next morning found ourselves with the thermometer 55° above zero, with a bright sun and no signs of the storm we had passed through but a few hours before. On, on we fly into Texas with the thermometer going higher the further we proceed. At Austin it was 70°, and our heavy underclothing felt a little uncomfortable. At Laredo we came to the

* Read at a pharmaceutical meeting of the Philadelphia College of Pharmacy, Nov. 21.—*From the American Journal of Pharmacy.*

border of the United States and Mexico, with a feeling that at last we were in Mexico.

From Laredo on the Rio Grande to the city of Monterey it is a distance of 170 miles. After a run of a few hours we stopped in a little town—Salinas. We found ourselves here confronting a civilization entirely different from that which we had left; here were one-story huts, thatched roof, a door but no windows, women and children at the door, and the children half naked. No floor but that of hard dirt, no furniture but a chair and stand with a lamp; a bundle of clothes in one corner, probably used as a bed. Flowers were in bloom, a species of cactus six feet high was growing everywhere, and the Spanish bayonet, a queer-shaped tree of the yucca variety, was the one prominent tree in the landscape. My vanilla expedition has now carried me about 2,200 miles from Philadelphia into new and strange surroundings. Let us stop for a moment in the investigation of a scene of interest.

We find here a singular and instructive commentary upon the silver question that is now agitating the country. I found in spending money that this is one of the best countries in the world for this purpose—the more money I spent the more I had left, owing to the very low price of silver, and Mexican finances being based on silver values. The Mexican dollar (or peso) is worth 65 cents and an American dollar is worth $1.60. When I bought $1.50 worth of goods, and gave a $5 note I received $6.25 in change, and it struck me as one of the most wonderful things in political economy that I had ever seen.

My next stop was in San Luis Potosi, 300 miles from Monterey. It has a population of 60,000. On the way you cross the Tropic of Cancer and pass from the temperate to the torrid zone. Here we come to fields and fields of the green century plant.

I next visited Toluca, some 300 miles south of San Luis Potosi and 45 miles north of the city of Mexico, the capital of the government, where I spent nine days.

Leaving the city of Mexico I proceeded to Pueblo, then to Jalapa, and on to Vera Cruz, taking the Ward's line of steamers up the coast to Tuxpan, where I arrived after a thirty hours' sail. Here a tug came to the mouth of the Tuxpan River and took me off, steaming up the river nine miles to the city of Tuxpan. The city has 10,000 inhabitants, and is composed principally of one-story, limestone, thatched houses, After spending three or four days here getting my outfit together, consisting of four mustangs, servants, guide and interpreter, we started early on Monday morning for the vanilla land.

Hastening on, we rode through a dense forest by a bridle path, where we had to go single file, which brought us to an Indian village on the Casonies River, after some thirty miles of hard riding, besides having to ford several rivers. I would state here that the sun is intensely hot at midday, so that the most of the people retire from about 11 to 2 o'clock. We stopped about 11 o'clock, at a small village composed of bamboo and thatched houses, where we waited until 4 o'clock before proceeding on our journey, and arriving at Casonies in the evening at about twilight. On the Casonies River we saw hundreds of Indian canoes plying up and down this stream with both men and women propelling them, which was a curious sight. We started early next morning for Papantla, where we arrived at about nine o'clock at night. This is some thirty-five miles further inland. It is a city of about 12,000 inhabitants, and is composed mostly of one-story limestone thatched houses. This is the metropolis of the vanilla growing district, situated in the valley surrounded by high mountains on all sides. This is the county seat. Court was in session when we arrived there, and it was impossible to get accommodations at the one hotel or any of the boarding houses. The hotel is a one-story building, composed of three or four rooms; these were all turned into sleeping rooms at night, and everybody had to sleep together—men and women; cots were arranged side by side, until there was scarcely room to get around. As the climate here is always warm, eating is done mostly out of doors. By the courtesy extended to me through letters of introduction I had, I was taken and well cared for by Mr. Tremari, who is one of the first citizens and the largest curer and shipper of vanillas in Papantla.

At last, after countless difficulties and strange experiences, I am at the goal of my journey—in the land of vanillas, in the center of a district from which a large portion of the world's supply of this luxury is derived, and in readiness to transform into a reality the dream of years; and from here I ask you to pause with me a moment to scan briefly the history of this strange and popular product, of which little is known to the general student.

When the Spaniards discovered America, the custom among the Aztecs of flavoring chocolate with vanilla was already in vogue. The former borrowed the practice from the latter and transmitted it in turn to the other nations of Europe. A few years later this valuable product became an export article, and it is believed that the first vanilla bean introduced into Spain came from the state of Oaxaca. It is raised in divers parts of the continent, in the Island of Cuba and other Antilles, and in some portions of Africa and Asia as well, and as a rule wherever there is heat and moisture and shade, provided the lowest temperature in winter be not lower than 65° F.

At first that which grew wild in the woods was harvested, and the inference is clear that, in proportion to its gradual diminution and increasing consumption, it was found necessary to foster its growth, and in this the state of Vera Cruz took the initiative, being the first place known in which the plant is under cultivation in America. Notwithstanding numerous inquiries made by me, I have found it well-nigh impossible, even with the aid of tradition, to ascertain the exact time in which the cultivation began; this alone being known, that the period is a remote one. From some of the old archives of Papantla we derive the information that in the year 1760 there were already in existence vanilla forests under cultivation. The state of Vera Cruz has had and to-day possesses great natural advantage for the production of vanilla. But it is cultivated only in the cantons of Misantla and Papantla. For a number of years Mexico supplied the markets of the world with this product, but of late years the islands of Bourbon and Java have come in competition with European markets to a marked degree.

With this brief history of the origin and nature of vanilla, start out with me on a bright, clear morning in the month of February, with the thermometer ranging from 85° to 100°; dressed in thin linen, with a light Panama hat, and mounted upon a mustang for our first visit to the vanilla fields, located about nine miles from Papantla. The first error that you need to correct is our northern conceptions of a field. It is not here the carefully tilled, snugly fenced, and finely cultivated tract of land that characterizes the marketable products of New Jersey or Pennsylvania, but a wild, boundless, dense and almost impenetrable forest, with undergrowth so dense and rank that our mustangs must be abandoned at a by-path, and we ourselves compelled to stoop almost to a creeping posture to penetrate it. Look at yonder tree—a Mexican cedar—20 feet in height, covered with dark green luxuriant verdure, with a small tapering trunk, a few feet in circumference, and clinging to and apparently growing out of its bark observe that strange looking, clinging vine, in circumference a little larger than an ordinary lead pencil, shooting up into the tree, covering its branches, and running from it into the adjoining trees, and often forming festoons and arbors so dense and thick as to exclude the rays of the sun at noonday. Covered with a dark green and spear shaped leaf, and hanging pendent from its interlacing branches, green pods, from four to ten inches long, and you have a picture of a vanilla vine as I first saw it in its native soil and in its highest state of cultivation. Tree after tree in this vast forest is covered with those luxuriant vines, peeping from which, in all the glory of tropical luxuriance, are countless hundreds of the long, luscious, tapering vanilla bean; in circumference almost equal to a banana and from two to three inches longer. Some of a dark green and others of a bright yellow, and sometimes where they grow most luxuriantly resembling bunches of bananas, apparently growing upon the native trees of the forests. The remoteness from civilization, the total absence of everything indicating care or cultivation, and the strange juxtaposition of this wealth of ripened fruit to the wild and unbounded woods made the scene one of the most strange and marvelous upon which the eye ever rested. Vast areas containing hundreds of square miles of contiguous territory in this province are devoted to the growth of this plant; wherever you look and wherever you travel you are confronted with this overhanging vegetation. You behold the primeval forest utilized by the half civilized natives as a natural garden for the growth of this delicious aromatic plant.

The cultivation of the plant consists of cutting away the forests to give it room to grow. The vines are naturally grown from cuttings, the same as grapevines, but they are also grown direct from the seeds, and in such cases the fruit is much later than when the vines are planted. The vine is very hardy in its native element, and sometimes takes root even if thrown carelessly on the ground, provided it has shade and moisture. Four or five years after the vine is planted, and sometimes before that period, its base rots at some distance, and before this occurs rootlets form above that portion which is dying, and have already grown and descended along the tree to get nourishment from the earth. This circumstance, added to the fact that if a reed be severed some distance from the ground it does not die, has given rise to two distinct theories respecting this plant, which I desire here to take the opportunity of correcting; the first theory, which has the support of many reputable scientists, is that the plant is epiphyte, deriving its sustenance from the atmosphere, and being independent of the soil, and the second that it is a parasite and derives its nourishment chiefly from the trees to which it clings. A careful examination of the plant in its natural forests and a patient study of its habits and characteristics have convinced me that both of these theories are founded in error, although, before my visit to Mexico, I confess I had been led to adopt the parasitic theory upon information from many intelligent growers.

Mr. Fuenti told me he had made the experiment of severing the reed two or three feet from the ground, and in a few days later two or more tendrils had sprung from the lower end of the vine and gone directly to the earth, thus replacing the lost base. The reed is very juicy, and when deprived of its roots tries to replace them, complying with the laws of its own existence; but this is done at its own expense, taking nothing from the tree, which statement is proved by the fact that if it consumes too much time in its endeavor to reach the soil it withers.

Should the tendrils reach the soil before the reed is entirely dried up, the latter recovers later; but if, on the contrary, its strength is not sufficient to accomplish the task of reaching the earth, it gradually withers until it does. In spite of the facility with which the reed takes root and replaces its base, some die, either because the reed was not fresh and sound or because it was damaged, or by reason of its being in localities where it received too much sun or too much shade.

I found others familiar with the vanilla growth contending that the plant depended for its nourishment and growth upon the sap of a particular tree—the cojondigate—and in support of this theory I was taken to the forest and shown vines growing luxuriantly around the base of this tree, showing great fertility and productiveness and a high state of health. But upon examination of the facts I found that this tree would grow only upon certain soil and under certain conditions, where the soil was always moist, and the reason that the vanilla grew so much better on this than on any other was because the conditions that so well suited the tree were the very conditions that best suited the vanilla plant, and when speaking of my observations in this direction, they admitted that it might be possible, and when finding in one of the gardens of Papantla a vine growing upon a dead tree, they could not but confess that it was perhaps not a parasite.

These good people had proved to me, or assured me, in their correspondence that the plant was a parasite, and it gives me pleasure to correct the error I was then laboring under.

After making diligent inquiry about the plant I had the pleasure of meeting Agopito Fontecilla, who I soon learned was an inteligent man, and who had made a scientific study of the plant, and to whom I am indebted for the greater part of my knowledge of the plant.

Taking the average of the last ten years, the number of beans that has been gathered each crop has been above 15,000,000, with the exception of a small quantity gathered on the southern coast of Vera Cruz, some 100,000. The remainder comes from the cantons of Papantla and Misantla, mostly from Papantla. The prices which it has attained during that time have varied much, ranging from $22 to $125 a thousand. According to the data in my possession it averages $60 to $70, and produces over $1,000,000.

The smallest unripe vanilla weighs 20 pounds to the thousand, and the largest 65 pounds to the thousand, and the average about 45 to 40 pounds. The average loss of weight in curing is about 9 pounds to the thousand. The length of the bean varies as much as its weight, measuring from 4½ to 10 inches; the greater part ranging from 7 to 8½ inches. The plant (Vanilla planifolia) grows a few yards in length each year, some portions of it clinging to the tree which supports it, and some remaining loose and hanging wave-like. Its thickness is about ⅜ to ½ inch. It is very juicy, round and of a green color, knotty at intervals; leaves alternate, shaped like spear and plump. The flower is yellow and has a sweet, agreeable smell. The plant grows in length only. It does not grow anything like a grapevine; it only bears fruit upon the new portion that grows each year. The thickness of the vanilla bean decreases gradually from two-thirds of the lower portion to the tip. Its shape is almost round, somewhat flattened on one side, curving up to the neck, which generally terminates in an arc. Its circumference varies, measuring when green from two to three inches, although the greater part measures three-fourths of an inch in diameter. It has a thin, smooth cuticle, with two superficial lines on either side. When thoroughly ripe its color varies from dark green to light yellow. Its lower portion is filled with small seeds, and after being treated its thickness is reduced to one-fourth of its original size. It remains black, oily and has an agreeable perfume.

Around Misantla there are often several varieties; these are known as Misantla bean, having thick skins. They are not packed as well, and are not considered as valuable as the Papantla curing. These varieties are designated by the natives as cimarrona, mestiza, manza. When cured only an expert can tell the different goods. The wild or pompoma bean, segne xante, or sometimes called banana vanilla by the Totonaca Indians, who eat them, is to be found here. This plant differs from that of the Vanilla planifolia in that it is much smaller, with larger leaves and less pointed. The bean is about twice as thick and of a triangular shape, somewhat resembling the ordinary banana when insufficiently nourished. It has an agreeable fragrance, resembling that of the anise plant. It is commonly and naturally supposed the beans grow and thicken until approaching ripeness. It is not so, for after it is two months and a half old it ceases to increase in size. Mr. Tremari said he had made several observations during the past two years, measuring vanilla from different vines, and has found that some after the middle and some after the last half of June have neither grown nor thickened in the least.

The vine puts forth many blossoms, but the greater part do not bear, and those attaining full growth fall, or turn yellow and crack prematurely, owing to some disease in the reed; the bean, however, clings to it. This serves as a pretext for some persons to say that in October and November the vanilla bean is ripe and should be cut, not bearing in mind that its apparent ripeness arises from sickness in the plant, as shown by its defective nutrition, being soft to the touch and lacking the solidity of the ripe bean.

I found that the plants grew best in virgin soil where streams and brooks abound, and where the earth is a little sandy, and the dampness is retained longer than in any other soil; in these places the vines grow luxuriantly and vigorously, and yield large fruit, a most important factor, when one considers how scarce rain is in this section between February and July. Marshy ground is likewise undesirable, as an excess of moisture rots the vine. It is found that plants do best where a little sunlight can reach them, and the largest growers have trimmed out the heavy foliage that covers many plants. Yet vines exposed too much to the sun yield little vanilla, and what they do yield is small; the plants soon get yellow and die in a few years. On the other hand, those with heavy foliage never thicken. Their color remains a rich green, and finally sickens. The bean they yield is likewise small, badly nourished, and ripeness is retarded. After setting out the vines, if they do well, they will commence to bear fruit in about three or four years; its yield increases for four or five years, when it begins to decrease. It bears little vanilla after the tenth year. These vines yield when fully developed 85 and some as high as 200, although these are very rare. Some vines have branches that bear as much as 12 to 15 beans.

The proper time for the Mexican vanilla bean to ripen is in January or February, but such a demand is made for the bean that for several years the growers begin to gather the crop in October and November, so that the harvest is over before the time it should have commenced, and this vanilla weighs one pound less to the thousand, and remains red and subject to changes.

Vanilla, if allowed to ripen naturally, remains black, juicy, and of a silvery hue shortly after its curing, and for many years it can be preserved unchanged, but if cut prematurely it is affected much as any other fruit naturally is when picked two or three months before the time, and it never looks as it should when this is done. In order to impart to the bean all the good properties of which it is susceptible it should be cut as it becomes yellow, for, if it be cut all at once, even though it be in the month of January (as was the practice some years ago), the result will be that a great portion of it will remain unripe, because as it blooms in March, April, or May, this same gradual change continues, everything being equal, until it ripens. There is, besides, another cause which brings about the same difference even in the case where they blossom together, and that is the greater or less shade afforded by the trees on which the vines grow. In former times, in compliance with an order from the government, the sub-delegates, and after them the civil authorities, were instructed to see that the unripe fruit should not be cut. When this duty fell to the lot of conscientious and active persons abuses were in a great measure avoided, but complete, satisfactory results were far from being attained on account of the scarcity of the necessary means to watch and pursue smugglers. At

other times the office was applied for by indolent persons, who regarded the orders of the government with indifference, and thus the law soon fell into disrepute, and was finally abolished by the government. The difference between the price of the vanilla picked during October and November and that picked after January is in the proportion of three to nine. Those acquainted with this fact, seeing those beans sell for the third what they know by their yearly experience could be sold for nine, because they do not want to wait two or three additional months, might think them foolish, or would imagine that poverty compelled them to suffer this loss; but it is neither the one thing nor the other, because these people are clear headed and their prosperity so general that it may be said there are no people in the world who live in greater ease than do these people of Papantla, and this is not alone due to the fertility of the soil and the good quality of the products which are obtained by cultivation, but also because in their forests important products grow wild which are the property of any one willing to gather them. The motives actuating these people in selling the vanilla before it is ripe are caused by avarice on the one hand and rascality on the other. The first vanilla sold has, as a rule, been stolen, and as it is cheap, though of poor quality, it is always a bargain for the buyer. The planters who have vanilla beans somewhat distant from their homes, as soon as they know of any purchase or sale, cut their own beans, fearful lest the same may be stolen, as they know by experience that, immediately upon the start of such traffic, complaints are heard from the unfortunates, who in a short time are deprived of the results of hard labor and care. This abnormal condition of affairs goes on, and thefts repeatedly occur even in the best guarded vanilla forests, whose owners cannot constantly oversee by day and by night, as other duties require their attention. For this reason they decide to cut and sell the vanilla bean at very low figures, rather than to suffer total loss. For no other reason is the fruit gathered and sold before it is thoroughly ripe. This unseasonable traffic, both immoral and highly prejudicial to the property interests of these cantons, should be checked by proper legislation; in this way the crop and the quality of the goods would be much greater, and the superior and delicate flavor that justly belongs to the best Mexican vanilla bean would make it esteemed above any other aroma in the world.

In curing vanilla it is an easy matter to impair it either by an excess or lack of dryness. Perfect curing is only attained when the bean is left in such a condition that it remains juicy and retains its greatest possible weight—a consummation which the expert should constantly aim at. If the vanilla is cut when ripe, success will be easy, but when cut prematurely, as has been the case during many years, art has to replace nature as far as possible, which can be done only through labor and substantial knowledge of the subject, so that some idea may be formed of the delicate care needed for this operation. Suffice it to say that even the best known experts sometimes permit the vanilla to dry too much, or else the greater part of it, not to say all, becomes filled with insects, either before or after the process of curing. It is only necessary to allow it to remain in the sun three or four minutes more or less than is required to bring about one or the other of these results. Great care and fine eyesight are required in the separation of the diseased from the sound, because, if only one remains undetected, it will mould and endanger other bundles in a short time. The curers in Papantla excel in curing and bunching the bundles, and in the regularity and evenness with which they classify the size and quality. As a rule, planters do not know how to prepare the bean; so they sell them in an unripe state to curers who yearly employ experts for that purpose. The beans are brought in by the natives in large and small lots, very similar to the way in which our country people bring in rags, butter, and eggs to the town storekeeper. The beans are first put in a sweat box, where they are sweated about 36 hours. They are then placed on mats in the sun if the day is bright and clear, and if not, they are placed in a large oven to dry. This requires the utmost care and attention, else the beans are easily spoiled. After the excess of moisture is dried out, they are again sweated. This operation is repeated until they are black. They are then placed in the sun in the middle of the day only from eleven to one; they are then put in racks in vanilla rooms, one above the other. While the curing is going on it is necessary to separate them with the utmost care; the discolored from the black bundles, the very small, the impoverished, those with skin woody at intervals, the ones with a tough, thick and smooth skin, and also the spotted, cracked or split beans, assorting them in their respective classes. The great care to be exercised in curing vanilla can be appreciated by what I have said before; but it is not amiss to observe that, however little it is over-dried, it is sufficient to reduce the weight almost one pound to the thousand, which would be a great loss; besides, the bean that is over-dried loses some of its color, and depreciates its value $1 or $2 a pound, which amounts to as much as the loss in weight. When the vanilla is thoroughly ripe it is easier to ascertain the required point of curing, and besides gives less trouble and is not so exposed to changes. It gets silvery white being cured, and in a few months it is crystallized, and will be preserved in this way for a number of years. If cut when unripe, just the opposite happens, for not only are few crystallized, but their keeping quality is poor. After the beans are thoroughly cured, which takes from three to four months, they are assorted in different sizes and bundled in bundles containing from 50 to 75 beans each. The different curers have different amounts for their packing. Some 50, some 60, others 70, and some 75 to their bundles. These bundles are all uniform in size according to length, and are placed in cans of 40 bundles each; then four or five of these cans of different sizes are packed in a case made of Mexican red cedar, which is the most plentiful wood grown here. A curer stated to me that the making of these cases was the most expensive part in putting the bean up, as they have no machinery, such as saw mills and planing mills. Everything must be done by hand, which necessarily takes some time to make one of these cases, as the corners of each are grooved and dovetailed together, making the case cost, when completed, from $2 to $3.

After the beans are cased the cases are then covered with a fiber matting made here by the Mexicans, and the beans are ready for shipment. Mules or burros, in some cases mustangs, are drawn up in line and two cases are strapped on the back of each animal, and started for the sea coast in caravans of perhaps eight or ten animals, with two or three attendants; then shipped on steamers for Europe and the United States.

In going from the interior of Mexico you will meet caravans of these beasts of burden laden with all kinds of merchandise, this being the only way of transportation. The authorities for some time have been endeavoring to get a railroad to Papantla, but as yet have been unsuccessful. The Aztecs or native Indians do not want to have any improvements. Several attempts have been made to survey a road, and just before reaching there I was advised of a civil engineer who had been sent to survey a route and who was next day after his arrival found hanging to one of the trees outside of the town. The natives do not want anything different from what they have been used to, and will sacrifice their lives in defense of what they consider their rights.

I returned to America with a conviction that notwithstanding our national character of penetrating to the utmost corners of the earth, as a people we know little or nothing of Mexico, a great, broad, rich, fertile tract of land, magnificently endowed by nature and so favorably located, as respects soil, climate, and physical conditions, that in my judgment it is ere long to become the most prolific source of supplies for many of the essential and valuable products needed by the world; and of her varied and valuable industries, none are more promising and give indications of more important growth than does the vanilla bean. The infusion of greater intelligence in the minds of the natives engaged in its development, the employment of better means for its preservation and cultivation, the opening of newer and larger districts for its supply and a more intimate and scientific knowledge of its natural requisites, would in a few years multiply manifold the volume of this commerce, and would permit it to be placed upon our markets and markets of the world in a far better condition, as respects quality, and at a price that would largely stimulate its use.

I returned to Philadelphia satisfied that my expedition had been of great practical value to me, and that if more merchants and business men, deeply interested in handling and marketing vanillas, could be induced to turn their interest and attention to the conditions and restrictions that surround the production, many of the difficulties and hazards that retard its cultivation, that make its production so precarious, and mar its perfections, and so materially increase the cost of transportation, would in a few years be materially overcome.

I look at the vanilla bean with a new interest. I see in it something of the history of a peculiar people. Its delicate aroma is to me suggestive of the bright blue sky, the blazing sun, the tropical luxury, and the rich atmosphere of the country where it grows, almost the spontaneous child of nature, yet so potential and useful in the varied needs of our complicated life of to-day.

I trust that the brief and hurried view of its habits and peculiarities that I have been able to give you in this brief talk have been of some interest and value from a scientific standpoint and may have tended to render more accurate and definite your botanic knowledge of the vanilla plant, and may have cleared away some of the superstitions and uncertainties that have in the past clouded its history. If so, the object of my talk will have been fully accomplished, and I will have been fully repaid for the little time I have spent in throwing together these somewhat desultory remarks.

## A JAPANESE FLOWER SELLER.

NOTHING could better illustrate the differences in appliances and taste between our own street dealers in cut flowers and those of sunny Japan than our cut The light framework of bamboo, with its short lengths of bamboo cut at a node, so as to retain water wherewith to preserve the freshness of the blossoms, grasses, iris stems, and leaves, and the basket-like arrangement of the bottom tier, is as unlike a coster's barrow or the flower girl's flat basket as it is possible to find. Apart from the prettiness of the whole as a street picture, compare the greater security enjoyed by the flowers, carried as the contrivance is by means of a pole resting on the shoulder of the man, to that of being rattled over the stones in a donkey cart to the detriment of everything carried. And what would our street boys be doing with the flowers in the hinder receptacle? They manage these things better in Japan.—*The Gardeners' Chronicle.*

A JAPANESE FLOWER SELLER.

## INTERESTING EXPERIMENTS IN GERMINATION.*

By G. J. ROMANES, F.R.S.

THE primary object of these experiments was to ascertain whether the power of germination continues in dry seeds after the greatest possible precautions have been taken to prevent any ordinary processes of respiration for practically any length of time.

The method adopted was to seal various kinds of seeds in vacuum tubes of high exhaustion, and after they had been exposed to the vacuum for a period of fifteen months to remove them from the tubes and sow them in flower pots buried in moist soil. In other cases, after the seeds had been *in vacuo* for a period of three months, they were transferred to sundry other tubes respectively charged with atmospheres of sundry pure gases or vapors (at the pressure of the air at time of sealing); after a further period of twelve months these sundry tubes were broken, and their contents sown as in previous case. In all cases, excepting that of clover, the seeds sown were weighed individually in chemical balances, and seeds of similar weights taken from the same original packets were similarly sown as controls.

The exhaustion of the tubes was kindly undertaken by Mr. Crookes, F.R.S., to whom I must express my best thanks for the assistance he has given. The kinds of seeds used were mustard, red beet, clover, peas, beans, spinach, cress, barley, and radish. In addition to vacuum tubes and control tubes containing air, others were charged with oxygen, hydrogen, nitrogen, carbon monoxide, sulphureted hydrogen, aqueous vapor, ether, and chloroform.

With the exception of the beans, where only two were sown, ten weighed seeds were sown out of each of the tubes, and also out of each of the control packets which had been kept in ordinary air from the first. These results amply prove that neither a vacuum of one-millionth of an atmosphere, nor the atmospheres of any of the gases and vapors named, exercised much, if any, effect on the germinating power of any of these seeds. I may add that the same remark applies to an atmosphere of carbon dioxide, although in the particular series of experiments quoted this gas was accidentally omitted.

A subsidiary object of these experiments was to ascertain whether any appreciable variations would be caused in plants grown from seeds which, before germination, had been submitted to the conditions above explained. Hundreds of plants of the kinds named were grown from the seeds in the various tubes. But

* Lately read before the Royal Society.

in no one instance was there the smallest deviation in any respect from the standard type grown from the corresponding control packet.

In the case of the beet root, a larger number of plants were developed in many of the pots than the ten seeds which had been sown in each. This I found to be due to the fact that beet root seeds very frequently throw up two seedlings apiece. Not so frequently, but still very often, they yield three, and sometimes even four.

Further experiments are in progress.

## CHRYSANTHEMUM ROBERT PETFIELD.

CHRYSANTHEMUM Robert Petfield, of which we give an illustration, is one of the most important of the several excellent additions that have been made by Mr. Robert Owen, of Maidenhead, to the incurved section, and promises to attain a high degree of popularity among cultivators of those refined flowers for competitive purposes. The blooms, as so well shown in the accompanying figure, are rather above the average in size, with fine outline and of great depth. The florets are especially broad, stout, very smooth, and finely incurved, the color soft rose, tinted mauve on the back of the florets, the face rich purple. It is unquestionably one of the most finely finished of the incurved chrysanthemums yet introduced, and as a middle row flower it will render substantial service. Our illustration shows the bloom "undressed," after it had made two journeys by post; but it would have been a very easy matter to have so arranged the florets that the bloom would have presented the high finish properly regarded as essential in the incurved section, but our object in figuring this

INCURVED CHRYSANTHEMUM, ROBERT PETFIELD.

fine variety is to show it grown without manipulation —*The Gardeners' Magazine.*

## DR. OLIVER WENDELL HOLMES.

THE venerable Autocrat of the Breakfast Table is honored among the chrysanthemum men of this country for his beautiful addition to the lore of their native flower. Some call him the chrysanthemum poet, but he is of course much better known from his general contributions to the prose and poetry of American—I may say English—literature. He is the last that is left to us of a long line of great American poets, though literature has been more of a pastime than a profession with him. There are many who will be surprised at this, for I am aware it is not generally known that the professor of the breakfast table is also a professor of anatomy and physiology, or that he has taught these important branches of science in some of the leading American colleges for more than forty years. He has, moreover, shown a devotion to real hard work in this line which is far from common. In the course of an address at a "breakfast" given in the poet's honor some years ago, President Eliot, of Harvard University, remarked: "It seems to me that it is my duty to remind all these poets, essayists and story tellers who are gathered here, that the main work of our friend's life has been of an altogether different nature. I know him as the professor of anatomy and physiology in the medical school of Harvard University for the last thirty-two years, and I know him to-day as one of the most active and hard working of our lecturers. Some of you, gentlemen, I observe, are lecturers by profession, at least during the winter months. Dr. Holmes delivers four lectures every week for eight months of the year. I am sure the lecturers by profession will understand that this task requires an extraordinary amount of mental and physical vigor, and I congratulate our friend on the weekly demonstration of that vigor which he gives in our medical school."

Dr. Holmes is not a horticulturist to any great extent, but he loves flowers, especially chrysanthemums, for their beauty alone. The greater part of his life has been spent in and around Boston, where he has had ample opportunity to note the rise and progress of American horticulture. The Massachusetts Horticultural Society operates in that city, but its splendid pioneer work has been felt in all parts of the country. Activity that influenced such a vast territory could not be without its effect on the mind of the keen observer and scientist, and he can appreciate accordingly the efforts of the florists and others to place mankind upon a higher plane. He can, like all broad-minded men, see the utility of seeking a beautiful ideal. He can excuse the wanton follies perpetrated in the name of floriculture, because he knows that they but pave the way to the refinement of art and morals which surely follows. His poems compliment the workers, and it is theirs to press still onward and further merit the generous praise their deeds have won. M. BARKER.

—*The Gardeners' Magazine.*

## EFFECTS OF ELECTRIC FLASH LIGHT ON PLANTS.

IN a recent paper read before the Royal Society on "Experiments in Heliotropism," by G. J. Romanes, F.R.S., he says:

I cannot find in the literature of heliotropism that any experiments have hitherto been made on the effects of interrupted illumination, when the periods of illumination are rendered as brief as possible—*i. e.*, instantaneous flashes of light. Accordingly I have conducted an extensive research on heliotropism, where the flashes have been caused either by means of electric sparks in a dark room, or by the opening of a photographic shutter placed before the plants in a camera obscura with an arc light or Swan burner, at a distance of several feet on the other side of the shutter. The electric sparks were made either with a Wimshurst machine, induction sparks, or by means of the following contrivance. From the binding screws of the condenser of a large induction coil copper wires were led to a cup of mercury, where, by means of an electromagnet suitably actuated by clockwork, a current was closed and opened at any desired intervals; each break was therefore accompanied by a brilliant spark. A thick plate of glass was interposed between the seedlings and the electrical apparatus. In all the experiments here described the plants employed were mustard seedlings (*Sinapis nigra*), previously grown in the dark until they had reached a height of between one and two inches. Save when the contrary is stated, in all the experiments comparative estimates were formed by using the same pot of seedlings; during the first half of a comparative experiment half of the seedlings were protected from the light by a cap of cardboard covering half the pot; during the second half of the experiment this cap was removed, and the pot turned round so as to expose the previously protected seedlings to the influence of the light. The principal results thus obtained, and frequently corroborated, were as follows:

I. Even having regard to the fact that for equal strength of a stimulus excitable tissues are more responsive in proportion to the suddenness of the stimulus (or in a kind of inverse proportion to the duration of the stimulus), the heliotropic effects of such flashing stimulation as is above described proved to be much greater than might have been antecedently expected. This was shown to be the case whether the effects were estimated by the rapidity with which the seedlings began to bend after the flashing stimulation was begun or by that with which they continued to bend until attaining a horizontal line of growth, *i. e.* bending to a right angle. Thus at a temperature of 70° F., and in a moist camera, vigorously growing seedlings begin to bend toward the electric sparks ten minutes after the latter begin to pass, and will bend through 45° in as many minutes; frequently they bend through another 45° in as many minutes more. This is a more rapid rate of bending than can be produced in the same pot of seedlings when the previously protected side is uncovered and exposed for similar durations of time, either to constant sunlight or to constant diffused daylight. This is the case even if the sparks (or flashes) succeed one another at intervals of only two seconds.

II. It would thus appear that the heliotropic influence of electric sparks (or flashes) is greater than can be produced by any other source of illumination. But in order to test this point more conclusively, I tried the experiment of exposing one half pot of seedlings in one camera to the constant light of a Swan burner and another half pot of similar seedlings in another camera, placed at the same distance from the same source of light, but provided with a flash shutter working at the rate of two seconds intervals. The amount of bending in similar times having been noted, the pots were then exchanged and their previously protected halves exposed to the constant and the flashing light respectively. In both cases, the rapidity with which the bending commenced and the extent to which it proceeded in a given time after commencement were considerably greater in the seedlings exposed to the flashing than to the constant source stimulation. The same is true if, instead of a Swan burner, the source of light is the sun.

III. Many experiments were tried in order to ascertain the smallest number of sparks in a given time which would produce any perceptible bending. Of course the results of such experiments varied to some extent with the condition of the seedlings. But in most cases, with vigorous young mustard seedlings and careful observation, bending could be proved to occur within fifteen to thirty minutes, if bright sparks were supplied at the rate of only one per minute. The most extreme sensitiveness that I have observed in these experiments was that of perceptible bending after half an hour's exposure to electrical sparks following one another at the rate of fifty in an hour. This result would appear to indicate that in heliotropism under flashing light there need be no summation or "staircase effect;" but that each flash or spark may produce its own effect independently of its predecessors or successors.

IV. It is noteworthy that, while the heliotropic effects of flashing light are thus so remarkable, they are unattended with the formation of any particle of chlorophyl. In the many hundred pots, and therefore many thousands of plants, which have passed under my observation in this research I have never seen the slightest shade of green tinging the etiolated seedlings which had bent toward flashing light. On one occasion I kept a stream of 100 sparks per second illuminating some mustard seedlings continuously for forty-eight hours; and although this experiment was made for the express purpose of ascertaining whether any chlorophyl would be formed under the most suitable conditions by means of flashing light, no change of color in any of the seedlings was produced.

With the exception of those mentioned in the last paragraph, all these results were obtained by using sparks from the coil condenser, as above explained. These sparks were very brilliant, and yielded the maximal results, which alone are here recorded.

## SUGAR FROM CORNSTALKS.

AT the present time, when the question of sugar is so prominent in the discussion of economic and financial matters, it seems to me that perhaps it may be worth while to turn our attention to a comparatively forgotten source of supply, and the following results recently obtained at the New York Experiment Station cannot but be of interest to our people.

It may not be generally known that so early as 1717 the General Court of the Colony of Connecticut issued a patent for making molasses from cornstalks, the conditions being that it should be as good and as cheap as could be got from the West Indies. Also that in a letter from Abigail Adams to her husband, John Adams, September 24, 1777, she says:

"An instance may be seen in the progress which is made in grinding cornstalks and boiling the liquor into molasses. Scarcely a town or parish within forty miles of us but what has several mills at work, and had the experiments been made a month sooner many thousand barrels would have been made. No less than eighty have been made in the small town of Manchester. It answers very well to distill, and may be boiled down to sugar. There are two mills fitting up in this parish. They have three rollers, one with cogs and two smooth. The stalks are stripped of the leaves and tops, so that it is no robbery to the cattle, and the juice ground out. It is said that four barrels of juice will make one of molasses, but in this people differ widely. They have a method of refining it so that it looks as well as the best imported molasses."

In 1790 the consumption of sugar in the United States was as follows:

| | | |
|---|---|---|
| Imported | 18,179,632 | pounds. |
| Domestic | 12,000,000 | " |
| Total | 30,179,632 | " |
| Population | 3,929,214 | |
| Per capita consumption | 7·68 | " |

Compare the above statistics with those for the year 1892, when the consumption of sugar was of

| | | |
|---|---|---|
| Imported | 1,593,126 | tons. |
| Domestic | 244,500 | " |
| Total | 1,837,626 | " |
| Total, 1891 | 1,872,400 | " |
| Per capita | 64·25 | pounds. |
| Per capita, 1891 | 67·46 | " |

It will be observed also that while in 1790 we produced about 40 per cent. of our total supply, in 1892 we produced a little over 13 per cent. of what we con-

sumed, and this fact, together with the small per capita consumption, resulted in so slight a tax upon the people for this commodity that the experimental results above recorded were apparently lost sight of and have not received the attention which they appear to have merited.

During the past few years the canning of fresh fruits and vegetables has grown to an extensive industry, and there are many towns throughout the Northern and Middle States having their local factories for the preparation of these products.

I am informed that the factory at Geneva has the past season canned the sweet corn grown upon 425 acres. In order to make a few preliminary experiments, I requested one of those who were daily hauling loads of ears by the station to bring me some average stalks, from which on analysis the following results were obtained:

*Stowell's Evergreen.*

| | |
|---|---|
| Juice stripped stalks, per cent | 41·1 |
| Sugar in juice, per cent | 9·44 |
| Glucose in juice, per cent | 2·72 |
| Specific gravity of juice | 1·065 |
| Average weight unstripped stalks, ounces | 16·7 |
| Average weight stripped stalks, ounces | 10·7 |

*Egyptian.*

| | |
|---|---|
| Juice stripped stalks, per cent | 44·7 |
| Sugar in juice, per cent | 6·88 |
| Glucose in juice, per cent | 2·72 |
| Specific gravity of juice | 1·049 |
| Average weight unstripped stalks, ounces | 28·3 |
| Average weight stripped stalks, ounces | 18·2 |

*Hiscock.*

| | |
|---|---|
| Juice stripped stalks, per cent | 45·0 |
| Sugar in juice, per cent | 10·09 |
| Glucose in juice, per cent | 2·32 |
| Specific gravity of juice | 1·067 |
| Average weight unstripped stalks, ounces | 18·5 |
| Average weight stripped stalks, ounces | 11·7 |

This would give the following in pounds:

*Stowell's Evergreen.*

| | |
|---|---|
| Unstripped stalks per acre | 15,745 |
| Stripped stalks per acre | 10,181 |
| Juice per acre | 4,151 |
| Sirup per acre | 731 |
| Cane sugar per acre | 392 |

*Egyptian.*

| | |
|---|---|
| Unstripped stalks per acre | 26,067 |
| Stripped stalks per acre | 16,713 |
| Juice per acre | 7,474 |
| Sirup per acre | 897 |
| Cane sugar per acre | 514 |

*Hiscock.*

| | |
|---|---|
| Unstripped stalks per acre | 15,725 |
| Stripped stalks per acre | 9,988 |
| Juice per acre | 4,499 |
| Sirup per acre | 697 |
| Cane sugar per acre | 454 |

From the above it will be seen that the average of juice extracted by the small hand mill used in these experiments was approximately 44 per cent. of the weight of the stripped stalks, but a much larger quantity was present in the stalks than that obtained in this way.

It is also to be remembered that the pressed stalks are in an excellent condition for preservation in the silo, and their nutritive value, for an equal weight, is increased rather than diminished by the removal of the 44 per cent. of juice—*i. e.*, a ton of the pressed stalks has a greater nutritive value than a ton of the unpressed stalks; so that we have, in addition, the leaves and tops not only, but the pressed stalks as food for cattle.

It will doubtless surprise many to learn that the juice from cornstalks is purer than that from sorghum, although there is generally a less percentage of sugar in the former than in the latter.—*Peter Collier, in the Country Gentleman.*

## HEREDITY.*

By M. F. PRICE, M.D., Colton, Cal.

HEREDITY is defined by Webster to be "Hereditary transmission of the physical and psychical qualities of parents to their offspring: the biological law by which living beings tend to repeat their characteristics in their descendants."

Other definitions may be quoted as follows:

"Hereditary descent or transmission, as of physical or mental qualities; hereditary succession or influence; in biology, the influence of parents upon offspring; transmission of qualities, or characteristics, mental or physical, from parent to offspring. The principle or fact of inheritance, or the transmission of physical or mental characteristics from parent to offspring, regarded as the conservative factor in evolution, opposing the tendency to variation under conditions and environments." (Cent. Dic.)

"By heredity is meant the tendency manifested by an organism to develop in the likeness of its progenitor." (Pop. Sci. Mo.)

"That every unfolding organism eventually takes the form of the class, order, genus and species from which it sprang is a fact which, by force of repetition, has acquired in our minds almost the aspect of a necessity." (H. Spencer.)

In the widest sense, heredity would signify that biological law by which individuals transmit to their posterity *all* the traits that characterize the species to which they belong, making it indispensable to permanence of species. It would include instinct, which is the innate intelligence derived from the experience of progenitors, and also all the characteristics of complexion, feature and mental traits which distinguish races, nations and families of mankind. (Ref. Hd. Bk.)

Generally, however, the definition is restricted to "Transmission of such physical and mental traits as serve to distinguish a few from the main body of their associates."

Just how this transmission of characteristics is accomplished is a difficult problem to solve. Recent research has thrown some light upon the structure and relations of male and female germ cells in connection with the phenomena of reproduction and heredity. Henry Fairfield Osborn has investigated the subject under two divisions, viz., that of germ cells—the expression of heredity—and body cells—the potential vehicles of heredity—and says: "The many problems resolve themselves into the simple questions: How do the parent germ cells transform into the offspring body, and how does the latter influence the *new* germ cells, or what are the total relations between the body cells and germ cells?" Galton introduced the term "stirp" to express the sum total of hereditary organic units contained in the fertilized ovum. He advanced the idea of *continuity* in the germ cells, and thus accounts for atavism, the transmission of "latent" characteristics. From this law he claims that "it is evident that only a part of the organic units of the 'stirp' becomes 'patent' in the individual body; some are retained in the germ cells, and only become 'patent' in the next generation or some succeeding generation."

Weisman's theory of heredity is that "there is a distinct form of protoplasm, with definite chemical and molecular properties, set apart as the vehicle of inheritance; this is the germ plasm, quite separate from the body cells. Congenital characters arise in the germ cells, while acquired characters arise in the body cells." (Ref. Hd. Bk.)

Osborn sums up by saying that "the facts of heredity support the theory of a continuous hereditary substance in the protoplasm as the basis of repetition of type, but do not favor Weisman's hypothesis that the germ cells alone contain this hereditary material." (Ref. Hd. Bk.)

There is a prevailing law with regard to the transmission of characteristics governing the species. An individual possessing a given trait to an exaggerated degree, mating with one with the same trait to an average degree, reduces the exaggeration perceptibly, while entire deficiency in the mate would reduce it to still greater extent. On the contrary, if both possessed the same exaggerated trait, the result would be an augmented deviation from the normal type.

Breeders of stock study and take advantage of this law to preserve and improve the purity of choice breeds in speed, size, endurance, docility, strength, fattening and dairy qualities, fineness of wool, etc.

Heredity is noticeable in a variety of traits which belong to certain families. One family is corpulent, another lean; one displays precocity in intellect, another is dull. Aptitude for mathematics, music or the fine arts is often observed to run through several generations. The Bachs were hereditary musicians. Herrick says: "Bad spelling, as well as lewdness, are occasional family traits." Some families are characterized for such virtues as business tact and integrity. The Rothschilds are hereditary bankers. Some families are noted for truthfulness, temperance and frugality; others are equally marked for dishonesty and drunkenness. Vicious and criminal propensities exist in some families for generations. Dr. Dugdale traces through six generations a remarkable example of this form of heredity in the descendants of a depraved woman named Margaret Jukes. Of 709 individuals, the great majority consisted of murderers, thieves, prostitutes and idiots. (Ref. Hd. Bk.)

A short time ago a lady in this city related to me an incident which illustrates this idea. A boy six years of age has a father belonging to the class of men who live on the earnings of fallen women. The boy had been separated from his father for three years and trained by a good mother. He is now living with his aunt, an excellent woman. One day this aunt gave him a nickel to buy some slate pencils. He went for the pencils and, after being a long time away, he came home with some candy also, claiming that he had bought and paid for both. Cross examination failed to elicit any information as to where he procured the extra money. The next morning it was learned that he had picked up a neighbor's pug dog and traded him for the pencils. At the book store he told a straight story about being the owner of the dog and that his aunt did not want him any longer; told the dog's name, etc., and could not be tripped in his story. This boy had been, for three years of his short life, trained under the most favorable circumstances, separated and far removed from the influence of his father and his evil associates. This boy's life will be one of contending elements; his heredity and environments ever at war, or perhaps two hereditary traits opposing each other.

It often happens that all our skill and research are put to the severest test to account for changeable morbid conditions. A patient is hypochondriacal, imaginative, "an instinctive pervert," and persists in declaring himself ill and miserable. We refer it to indigestion, reflex neurosis, etc., and yet "something must be found and acted upon if we would obviate lifelong invalidism." These difficulties may be accounted for by a hereditary transmission of traits of both parents existing separately in the offspring.

Dr. Smith Baker, in a paper read before the American Neurological Association on "Heterogeneous Personality," gives some instances of this double heredity, one of which I will quote. "A little girl about four years old was brought to me as a sort of professional puzzle. She was one whose very bright, beautiful, winsome, affectionate nature had rapidly endeared her to all, and I found her unusually imaginative and inventive, rather precocious as to powers of observation—altogether an attractive child, and without physical abnormality so far as could be discovered. Yet I was informed that she irregularly presented these characteristics: for a few days she would be a normally healthy girl, and a cheery, smooth-tempered playmate of everybody. Then would follow a season, varying in length from a few hours to a couple of days, during which she would manifest all sorts of perversions of bodily function and of mental and moral life. Indigestion, constipation and irritable bladder; bounding heart, flushed cheeks, with no corresponding rise of temperature and no accounting characteristic of urine; fidgety, sleepless, cross, vindictive, dull, but explosive in every direction—apparently another child for the time being—one who had puzzled parents, nurses and physicians, both as regards diagnosis and treatment. Hysteria, hydrocephalus, worms, vaginitis, eye strain, detective valves, Bright's disease, malarial and liver troubles had been the supposed sources as yet most frequently drawn upon to account for the phenomena; while panto-pathic almost had been the methods of attempted relief."

In his investigations Dr. Baker says he adopted almost multitudinous methods, theories and reasonings—local areas of irritation; reflexes, ocular, nasal, sexual, abdominal, cutaneous; the heart, liver, lungs, kidneys; the cerebro-spinal and sympathetic systems—all to be in turn declared barren or wrong. Finally, he thought back upon what he had known of the family antecedents of the child. "Her mother was the only daughter of two people who were so unlike, not only in physique, but also in mental and moral traits, that on the ground of contrast only could their marriage be accounted for." When their daughter, the child's mother, was about fourteen years of age she presented certain functional peculiarities that were very marked, and experienced a series of alternations, during which she would be at times the veritable child of her father, and at others her mother's own child, thus giving a "heterogeneous personality in which, at least, two factors were unblendable in the personal whole." These two "unblendable factors" in the mother were apparently transmitted to the child.

If we but knew it, there are many in our midst among our associates who are leading a double life; the transmitted traits constantly at war with each other, or with the environments of the individual, a double or "duplex consciousness."

In the matter of the transmission of acquired characteristics and mutilations there is great diversity of opinion, but I think there is abundant evidence to prove that they are transmitted to offspring. I know a family with whose history I am familiar for several generations. The individual members have been ordinary "Pennsylvania Dutch" farmers. Some three generations ago one of the boys of a large family left the usual path so long followed and became an educated man by his own efforts, not college educated, but, as Senator Stewart has said, "by contact and association with the people." He adopted and became proficient in a profession. His children are all now in active professional life, proficient and prominent. The same view is also "especially illustrated in the extraordinary contribution of the sons of clergymen to the ranks of men eminent in intellectual attainments."

Much credit is due in such cases to the parental attention paid by the educated to the education of their children. It is hard to separate the influence of heredity from that of the environments.

At the last meeting of this society our worthy President, Dr. C. L. Bard, read a paper in which he recorded the result of some original study bearing upon this subject. This author claims that "in the horse the *trot* is an *acquired* gait which has taken years to perfect. Before his subjugation it was unknown," and that the reindeer is the only animal in which the trot is the natural gait. No one will now pretend to claim that this acquired gait is not transmitted. As before intimated, stock breeders take advantage of this law of heredity, while they are ignorant of the fact that what they try to improve is an acquired characteristic.

About a year ago my little boy procured and brought home a very much emaciated kitten, which had received an injury to the end of its tail. About an inch and a half of the tail was sore, covered with scabs and apparently dead. One day, while the boy was fondling the kitten, the sore end of its tail dropped off. The cat grew and prospered, notwithstanding the abbreviated extremity, and in due course of time became the mother of a litter of kittens, of which two only lived. One of these was born with a tail about half the usual length and the other with the tail in the condition the mother's was when my boy brought her home, and which, like the mother's, dropped off, leaving it like its brother, with a shortened and stumpy tail. These kittens are now six months old, and, with the mother, are quite a novelty in the neighborhood, as well as convincing proof of the hereditary transmission of acquired characteristics.

A lady living near neighbor to me is the possessor of a litter of eight puppies, whose father and mother both have short tails, the result of mutilation. Only two of these puppies have long tails. Of the other six some have short stumps and others no sign of tail.

In Yuma, Arizona, I once knew a family of puppies, about half of which had no tail at all, not even a stump. The mother of the puppies was tailless; the fathers were probably numerous and with long tails.

There is a woman living in my town whose fingers and toes are one phalanx shorter than normal, the nails appearing on the second phalanges of the eight fingers and eight toes, the thumbs and great toes being the usual length. She has two sons and one daughter who inherit the same deformity. On the eighth of September last an illegitimate grandson was born with the toes short, but fingers normal. The fathers in both cases had no deformity. The woman is ignorant and quite sensitive on the subject; therefore I could get no history back of her mother, who, she says, had short fingers and toes.

We are all familiar with the experiments of Weisman with white mice, by which he seemed to prove the contrary of this law. He cut off tails for nine generations and failed to produce a tailless breed.

Some years ago a German physician tried the same experiment with like results. He was led to make the experiment by finding a number of tailless cats in the neighborhood of the Black Forest, and while trying to acertain the cause of the peculiarity he found a litter of kittens, of which some had tails and some had none. While further pursuing the investigation he came across a lady living near who owned a genuine Manx Thomas cat (a tailless breed), and it was to the "gallantry and attentions of this energetic animal that the curtailed cats were due."

The experiment with white mice, detailed above, has since been tried by an American physician with exactly opposite results—the tail disappearing. It could also be made to reappear. In fact it could be bred off or on at pleasure. (Med Abs.)

Brown-Sequard conducted some experiments upon guinea pigs in which the acquired variation was in-

* Read before the twelfth semi-annual meeting of the Southern California Medical Association, held at Los Angeles, December 6 and 7, 1893.—*Southern California Practitioner.*

tensified. He had abnormal degeneration of the toes, muscular atrophy of the thigh, epilepsy, exophthalmos, etc., in the descendants of animals in which the spinal cord or sciatic nerve had been severed, or portions of the brain removed. He also claims to have demonstrated that the female was more apt to transmit the morbid state than the male, and also that they may pass over one generation and reappear in the second, and the influence may continue for five or six generations. (Ref. Hd. Bk.)

Dr. A. L. Hodgdon quotes an interesting case reported by Dr. R. A. Lancaster: "Mr. O. D. M. received a pistol shot wound in the neck near the base of the skull, which came near proving fatal. He finally recovered, however, except that there remains a paralysis of the right side. In walking there is peculiar dragging of the foot, which is quite noticeable. Some years after the accident he was married, and in due course of time a fine healthy boy was born. The mother, who is a very intelligent lady, confesses that she had some misgivings lest the babe might have its father's deformity, which happily was not the case. A second boy was born to them about two years later, and this also was a perfectly formed child. After this *the mother gave no further thought* to the idea of the father's condition impressing itself upon the offspring. About two and a half years later a third son was born, and to the surprise of all—and to none more than to the mother, for she had not given the possibility a thought in the case—he was the exact reproduction of the father, the right arm and leg being somewhat drawn and wasted. The child is now eight years old, and his walk and every motion are precisely like his father's, and no treatment seems to benefit him in the least."

On the subject of "maternal impressions," Dr. Hodgdon appends the following foot-note to this case: "An interesting conclusion might be drawn from what here *occurred after* 'the mother gave no thought,' *opposite* to what happened while she had given thought—warding off the hereditability, as it were, by her fears." I think, however, that it can be better explained by the principle of atavism—part of the "stirp" remaining "latent" in the two and becoming "patent" in the third child, for I am not convinced that there is any truth in the theory of "maternal impressions."

This paper has already reached too great a length to permit of more than a passing note upon the point which is of peculiar interest to physicians—the transmission of disease. My object has been to call attention to facts in heredity that are not often brought to notice. All recognize that numerous diseases are inherited.

Herrick gives a long list: "Of these the most marked are goiter and cretinism, leprosy, gout, scrofula, tuberculosis, cancer, rheumatism, scaly cutaneous affections and the neuroses—epilepsy, insanity, chorea, hysteria and asthma. Heredity is less frequent, but undoubtedly operative in organic disease of the heart, hemophilia and lithiasis. To these should be added color blindness, whose rule of transmission is curious. Females are about one-twenty-fifth as liable to be affected as males, but the color blind transmit their peculiarity to their grandsons through their daughters who have normal color perception, as well as their sons. So this defect recurs in alternate generations in the female line, the females rarely being affected." (Ref. Hd. Bk.)

Some of these diseases are not congenital, and some are absent until old age. It is the predisposition in these cases, not the disease, that is hereditary.

The attention of physicians is perhaps most often called to tuberculosis and insanity of the above list and to syphilis.

Consumption is regarded as a disease of adult life, but in my opinion children are often affected and die of the disease. Of my own two children, one died, at eight months of age, with consumption with all its harassing symptoms—cough, expectoration and emaciation to the greatest degree. The other died at three months with acute phthisis following cold. Their mother died shortly afterward with pulmonary tuberculosis, inherited from her father. Acquired consumption becomes hereditary at once, and the next generation inherits the predisposition to it. I knew a gentleman in Washington City who had five children. The three eldest are now living, well advanced in life. After these three were born the father had a severe pneumonia which left him with a lingering pulmonary trouble that undoubtedly became tuberculous, and with which he finally died. After this had set in two other children were born, both of whom died at twenty to twenty-five years of age with consumption.

Syphilis can be transmitted by the father or mother to the offspring, although Dr. F. R. Sturgis has taught that the father cannot transmit it unless the mother also becomes diseased. I find other authors do not agree with him, nor does my own experience. I have known children who showed all the signs and symptoms of the disease, whose mother, to my certain knowledge, had never been affected.

It has been claimed by some authors that insanity is *always* hereditary, and with this view I am inclined to coincide. Of course, there may be cases of loss of mind from traumatism, or a delirium from disease, which may become chronic and perhaps properly classed as insane, but insanity *per se* is almost, if not always, the product of heredity. The testimony of the relatives of the insane does not amount to much. They will claim that there never was any insanity in the family from "away back" on either side, but such statements are of little value. Insanity is not always recognized, even by neighbors and relatives. They pass as "eccentric," "absent minded," "queer," etc.; but there is a neurotic diathesis that will sometimes show itself in a case of undoubted insanity.

Fielding Blanford says: "Though the parents may not have been insane, they may have been chronic drunkards, epileptics, hypochondriacs, weak-minded, or have indicated their nervous condition by chorea, stammering and the like, and although the parents may not have been insane, insanity may have existed in their parents and reappeared in the grandchildren, skipping a generation." (Insanity and its Treatment.)

It does not follow from this reasoning that the offspring of the insane are all insane; some may be so and others idiotic, epileptic, deaf mutes or simply nervous, and others perfectly sane and sound. "There is a tendency in all diatheses to return to the type of health, if there is sufficient vitality to perpetuate existence, otherwise we should have sterility and finally extinction."

Where this heredity exists, the subject thereof may go through life without its showing itself; but should any exciting cause supervene, such as a severe illness or great mental anxiety, any undue exercise of the emotions, religious excitement; any extreme terror or rage, the mind may become unbalanced and the hereditary tendency assert itself.

If the facts herein presented are true, that mental and physical qualities—morality and vice, virtue and lewdness, perfect and deformed bodies, health and disease—can be transmitted to offspring, as well as the fact that there is no reasonable doubt that the transmission of hereditary disease can be as effectually prevented in the human race as in domestic animals, then the moral I would impress is that the mating of human pairs should be under as wise control as is the breeding of stock. Farmers castrate and spay their ordinary animals, and thus deprive them of their procreative powers; "but the ordinary, diseased and idiotic human is allowed to burden the state with pauper and criminal offspring that become innumerable in the generations of which he is the ancestor." (Walter Lindley, M.D.)

Ella Wheeler Wilcox spoke more wisely, perhaps, than she thought when she said: "I think the best and surest way to reform a man is to begin with his grandparents. If the young woman who is contemplating marriage will take this idea into consideration and act accordingly, she will be saving some other woman a century hence the trouble of reforming her grandson. Nothing is more absurd than for two young people to declare that their love affair is their own business wholly. Results are every day convincing us that the marriage of any two people is an affair which concerns the interest of a whole community. The young woman who runs away with a dissipated or a dishonest man and marries him against the wishes of her friends is not merely causing herself sorrow, but she is causing sorrow for women unborn. Therefore I say, if you wish to reform the world, let us begin with the grandparents of unborn generations."

## THE RECIDIVIST.

By JAMES WEIR, Jr.

SOME time since, one of the current magazines published an article under the caption, "Criminals Not the Victims of Heredity." The writer of the above-mentioned article, in summing up, advances ten propositions for the proper treatment of criminals, and these ten propositions are founded on the cardinal proposition that "a criminal is like any other man." It is the purpose of the present writer to show, by unimpeachable and incontrovertible evidence, that this last proposition is unquestionably false. The writer referred to makes the common mistake of confounding the various criminal types. He makes an indiscriminate use of the terms professional, habitual and congenital criminal. A professional criminal is not a congenital criminal, nor is a recidivist necessarily a professional criminal. I presume that he means the recidivist all through his article. I will, therefore, endeavor to prove that the congenital recidivist is, anatomically and physiologically, entirely different from normal man. I propose to give facts and facts alone. I do not propose to enter the domain of speculative psychology, nor do I intend to grapple with the grave questions now agitating sociologists and penologists. The statement that the recidivist is, anatomically and physiologically, an abnormal type of man is not the conclusion of an hour or day, but is the rational deduction obtained from days, months and years spent at the dissecting table and microscope, and in the study of the criminal, both in a state of freedom and while incarcerated.

The criminal physiognomy is of so marked a type that most men are able to recognize it at a glance. I took six photographs of criminals (five of them were recidivists and one of them an *occasional* criminal), and showed them to a hundred men, with the following statement and request: "Here are six criminals, five of them are habitual malefactors, and one of them is, comparatively speaking, an honest man: pick out the honest man." Ninety-five men out of the hundred picked out the photograph of the *occasional* criminal without a second's hesitation (*vide New York Medical Record*, "Criminal Anthropology"). The discriminating and exact Maudsley says in "Responsibility in Mental Disease," p. 29: "All persons who have made criminals their study recognize a distinct criminal class of beings, who herd together in our large cities in a thieves' quarter, giving themselves up to intemperance, rioting in debauchery, without regard to marriage ties or the bars of consanguinity, and *propagating* a criminal population of degenerate beings. For it is, furthermore, a matter of observation that this criminal class constitutes a *degenerate or morbid variety of mankind, marked by peculiar low physical and mental characteristics*. . . . . Their *family likeness* betrays them as fellows 'by the hand of nature marked, quoted and signed to do a deed of shame.'"

I have italicized certain words in the above quotation for obvious reasons. A celebrated criminal lawyer of New York once told me that he could tell a recidivist at a glance, and that he never made a mistake in his diagnosis of moral obliquity. Prof. Enrico Ferri, an Italian anthropologist, says that on one occasion he examined several hundred soldiers and found only one whose face declared him to be a criminal. He afterward ascertained that this man had committed murder. Lombroso submitted to thirty-two young girls the photographs of twenty thieves and twenty moral men. Eighty per cent. of these girls recognized the first as malefactors, the second as moral, upright men (*vide* Lombroso, *L'Uomo Delinquente*). Emile Gautier, who was confined for a time in Lyons prison, says: "These criminals have a general *family resemblance*, which makes them a class apart."

A warden of an Eastern penitentiary (Sing Sing) told me that there were not only twins in every prison, but that there were "triplets, quadruplets—aye, even twelvelets" (*sic*)! The criminal physiognomy is alike in all nations. The German criminal is not unlike the Italian, nor is the French unlike the American criminal. Says M. Joly: "I should say that in M. Bertillon's office I was shown nearly sixty photographs of Irish, English and American thieves. It would have been difficult in many cases to discern the Anglo-Saxon *rather than any other physiognomy*." Now let us analyze the criminal physiognomy, feature by feature, and see what constitutes this universal and well-marked type.

The observations of the writer, when in pursuit of this analysis, were not confined to any particular class of criminals. He examined all classes. He soon found out, however, that this distinctive type was to be found in congenital recidivists alone. The occasional criminal and the professional criminal—*i. e.*, the criminal by calculation—were found to be, anatomically and physiologically, normal. In the recidivist there is a marked exaggeration of the cephalic indices. In a dolichocephalic (long head) recidivist, the dolichocephalism is very marked. A like exaggeration is found in brachycephalic recidivists. Oxycephalism (sugar-loaf head) is very frequently observed. In three hundred drawings, taken from live and dead subjects by the writer, one hundred and ninety-eight are oxycephalic. Lauvergne says of this kind of head: "Where it is complete—that is to say, where it presents a prominent base supporting an inclined pyramid, more or less truncated—this head announces the monstrous alliance of the most eminent faculty of man—genius, with the most pronounced impulses to rape, murder and theft." The bilateral elevation of the sagittal sutures, "Benedikt's lines," have been observed in a number of recidivists. Prof. Benedikt considers these sutural elevations of great importance in criminal anthropology, and in his work *Kraniometrie und Kephalometrie*, says that "though rare, when present they are significant of great moral obliquity."

There is generally marked enlargement in the orbital arches of recidivists, together with receding foreheads. In three hundred and fifty of the four hundred quarter-face photographs of habitual criminals that I have examined, this enlargement of the orbital arches was plainly noticeable. In the two hundred drawings and photographs forming my collection, it is noticeable in one hundred and eighty-two. Tenchini and Lombroso, as well as Benedikt, have pointed out this abnormality in the orbital arches of criminals. Tenchini says that the frontal crest in normal man is 3 to 4 millimeters in length; in criminals, frequently 5 to 6 mm. "It is larger in the lower races, and relatively larger in orang-outangs." In my collection of skulls, there are four skulls of recidivists; all of these show this thickening. Prognathism is a marked characteristic in the physiognomy of the criminal. The large, heavy lower jaw and protruding mouth strike the observer at once. This feature is rarely absent in the congenital criminal. It is an abnormality eloquent in its atavistic suggestiveness. The low, receding forehead, the enlarged orbital arches, the prognathous jaws and high cheek bones of the congenital criminal are strikingly like those of our pithecoid ancestors. Just here it is proper to state that in an article on "Examination and Viraginity," which appeared in the *New York Medical Record*, September 16, I asserted that atavism is found only in individuals of a neurasthenic type. This, in a measure, is true in all cases of reversion; but it is well to remember that in the article alluded to I had reference to psycho-sexual atavism only. Sexual perversion and psychic hermaphroditism are of frequent occurrence in the recidivist; I do not intend, however, to discuss them here. I have examined, macroscopically and microscopically, twenty-three criminal brains. Twenty of these brains were those of recidivists, and abnormalities were found in all of them. In one of them, taken from a criminal executed for attempted rape and murder, there was confluence of the fissures. In a number of them the frontal lobe presented four convolutions; in all of them there was deficiency in weight. In several the gray matter was scanty and thin, and the convolutions superficial and few in number. Havelock Ellis says: "A variety of pathological features have been found in the cerebral substance and membranes—pigmentation, degenerating capillaries," etc. He then adds, in conclusion: "It must be added, as a point of considerable importance, that in very few cases" (he is speaking of the criminal class) "have these pathological lesions produced any traceable symptoms during life." There are two kinds of abnormal ears found in the criminal type: large outstanding ears, like those of the chimpanzee, and ears small and closely applied to the skull, like those of the gorilla. I have found that the small ear is generally possessed by the pickpocket and the sneak-thief, while the large ear is possessed by the burglar with murderous tendencies. In all my experience I have never seen an habitual petty thief with a large ear, while all burglar-murderers whom I have examined had large ears. A prison keeper said to me on one occasion: "I can tell a thief from a murderer every time by the size and shape of his ears."

I have thirty-six sketches of pickpockets. These drawings were made from life and are drawn to scale, and in all of them the ear is small and frequently misshapen. One sketch, made of a convict now in an Indiana penitentiary, shows the strange abnormality of a forked helix. Féré and Ségelas present a cut of an ear somewhat like the sketch just mentioned. The ears of recidivists are apt to be abnormal in many respects. Most of these abnormalities are undoubted atavistic attempts. Especially is this true of the small gorilla-like ear and the large projecting chimpanzee-like ear. The recidivist has a peculiar, feral stare, which, once seen and noted, can never be forgotten. A noted detective (Bligh, of Louisville, Ky., now dead) called it the "ape eye." "Look," said he to me on one occasion when were discussing criminals; "look at the next ape you see and you will know what I mea." (*sic*). The congenital criminal, when looking at you, seems to focus his sight on a point beyond you. It is difficult to describe this look. Bligh's "ape eye" comes nearer to it than anything else I can think of. Some of the special senses in recidivists are very much exaggerated.

The hearing of twenty-eight congenital criminals tested by me with the watch was found to be more acute than normal. Some of them possessed the microscopic sight of birds, describing the appearance of minute objects correctly, the details of which, to be seen, rendered for me the use of a lens absolutely necessary. I may add that my eyes are normal. Others

were able to read the printed Snellen's type double the normal distance. The sense of smell was decidedly more acute than normal. I bathed my hands in water scented with a few drops of violet perfume; they were then carefully dried. Three billiard balls were then held in the hands for a few moments, and then deposited on a table with half a dozen others. Thirteen recidivists out of twenty-eight picked out the balls which had been handled, declaring that they could plainly distinguish the violet odor. This experiment had been tried before with normal men, none of whom picked out the balls. I once knew a recidivist in St. Louis who could tell his friends by their personal odors. I have seen him do this time and again.

Spencer, in his "Sociology," gives a like instance of acuteness of smell in savages. I had the skull of this St. Louis recidivist in my cabinet for several years. It was stolen, however, and is now, probably, in the possession of some medical college or museum. It was strikingly like the skull of the Man of Spy (*vide Man in the Glacial Period*, Wright, p. 277), and was an extraordinary instance of atavism in every structural characteristic. There are two features yet remaining in the criminal physiognomy which I ought to have mentioned before discussing the special senses. We have all noticed the aged appearance of criminals, whether young in years or old. This appearance is due to the wrinkles that form about the mouth and eyes. Here the resemblance to the anthropoid apes again crops out. I have known youthful criminals so wrinkled that, in this respect, they resembled normal men five times their a e. In aged recidivists there appears on the upper eyelid, at the inner angle, a triangular fold or wrinkle. This wrinkle I have repeatedly noticed on the upper eyelids of the larger anthropoid apes. It is rarely present in normal man. High cheek bones are other prominent features in the criminal physiognomy. They are seldom absent in the congenital recidivist.

I have now analyzed the physiognomy of the recidivist feature by feature. When I place each feature in its proper place, I construct a mosaic of a variety in the human race entirely different from normal man. The brain, the seat of the moral function, is involved as well as bone, nerve and tissue. I have not carried this analysis of the congenital criminal beyond the head and face. I have said nothing of color (pallor), of the hair, of cutaneous sensibility, of the form and shape of the extremities, and of numerous other abnormalities. Without this additional evidence I think that I have proved that the congenital recidivist is *not* "like any other man." It is a principle of logic that one cannot combat assertions which are unsupported by arguments. The article referred to in the beginning of this paper is made up of assertions, the bases of which are founded on personal beliefs. It is the old story of religion against science; the old mistake of separating mind and brain matter, when, in fact, the two are identical. I am not an Averroist, nor am a believer in the doctrines of emanation and absorption. But I do believe, and this belief can be proved to be correct, that wherever there are receptive ganglia, whether in organisms high or low in the scale of animal life, there this element of life, which the Greeks called $\psi\tilde{\upsilon}\chi\eta$, psyche, enters in. It is just as much under the dominion and control of evolution as is the body, and is subject to the same laws. Morals are the result of evolution and are, unquestionably, a mental function subject to the laws of evolution. I regard the congenital recidivist as a moral imbecile, rendered such by the phenomenon of atavism.

## EXCAVATIONS AT DOUGGA.

Dr. Carton, one of the most distinguished of archæologists, recently communicated to the Academy of Inscriptions and Belles-lettres the results of the excavations directed by him in Tunis in the course of a mission intrusted to him by the Minister of Public Instruction.

At Dougga, a village situated at a short distance from Tunis, Dr. Carton disengaged the ruins of several Roman edifices of the greatest interest, and, among others, a theater in a surprising state of preservation for its age. It is this structure that our engravings represent under two aspects.

Almost entirely buried at first, it showed nothing but the upper benches and the heads of a few columns of the stage that remained standing. Upon having a stratum of rubbish five meters in depth and more than two thousand cubic meters of earth removed, the explorer laid bare the *cavea* (the part appropriated to the spectators), with twenty-five perfectly intact rising stone benches and a stage twenty-five meters in width. The latter was paved with a mosaic of white slabs provided with a green border. Of the forty columns that stood in the center as well as in the *proscenium*, twenty-five still remain. Externally, on three sides it is surrounded by a promenade six meters in width. The dependencies, that is to say, the foyer, six stairways leading to it and the wings, were likewise unearthed. Among the vestiges exhumed must be mentioned a colossal statue of excellent workmanship, but unfortunately headless. Moreover, precise inscriptions were everywhere found. One of them, at the foot of the statue of the Emperor Probus, celebrates the prosperity of the empire. Another, running over the arcades of the *summa cavea*, makes known the approximate date of the construction under Marcus Aurelius. A third, placed upon the frieze of the portico of the stage, recalls the fact that Marcius Quadratus, in memory of his elevation to the dignity of *flamen perpetuus*, erected this theater at his expense, and enumerates the rejoicings that he offered on the occasion of the inauguration.

The edifice measures no less than seventy-five meters in its greatest dimensions. It is remarkable, not only for its architecture, but also for its situation. From the top of the benches one takes in these majestic ruins at a glance, and, through the colonnade of the stage, like a superb scene-painting, he perceives the valley of the Khalledk and the mountain of Sidi Cheidi. Dr Carton, by his patient labors, deserves well of archæologists and tourists.—*L'Illustration.*

## THE NEW REICHSTAG BUILDING, BERLIN.

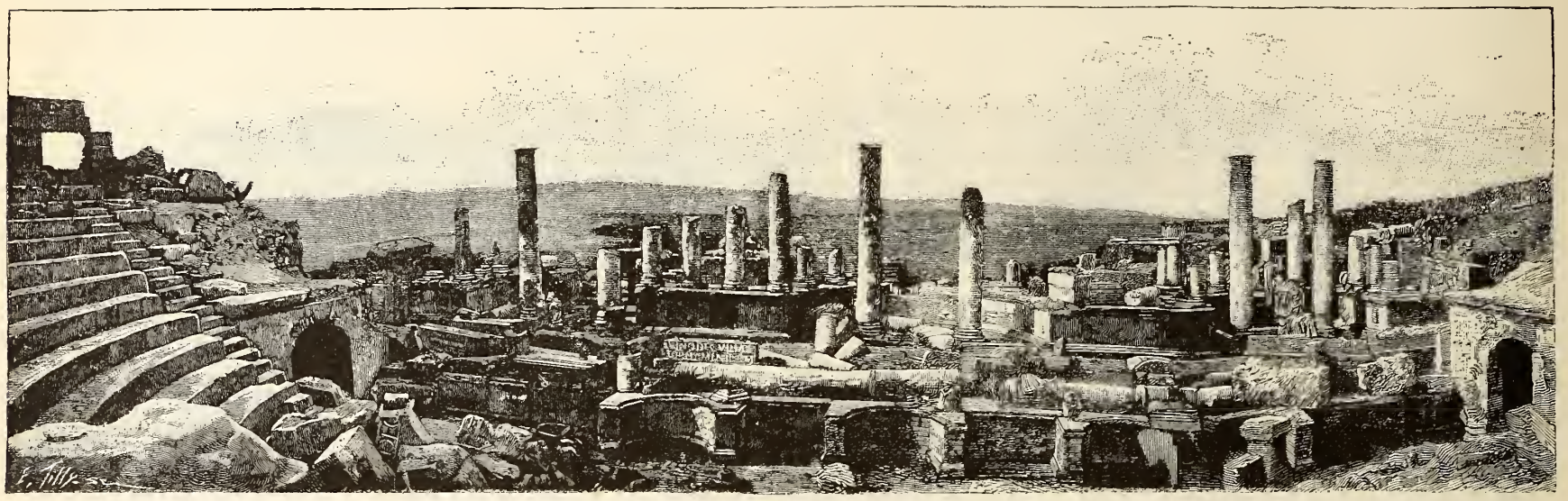
The exterior of the new Reichstag building, a production of Paul Wallot's, is now complete. It is executed in that style of architecture that was evolved from those forms of the Italian renaissance once handled in such masterly manner by Pallado and Sanmichele. The structure stands on the Koingplatz, near the Brandenburg gate of Berlin, in sight of the triumphal column, a proud monument to German unity, and it will be, for centuries, a reminder of the great times that inflamed the national feeling, inciting patriots to struggle with the enemy, and inspiring art.

The prize offered for the first competition of designs for a Reichstag building was won by Ludwig Bohnstedt, of Gotha, who has since died; but in the second competition Paul Wallot, then an architect in Frankfort, was successful. His design, however, had to be altered somewhat before it was entirely satisfactory, and even after the laying of the corner stone, on June 9, 1884, Wallot had to make some changes.

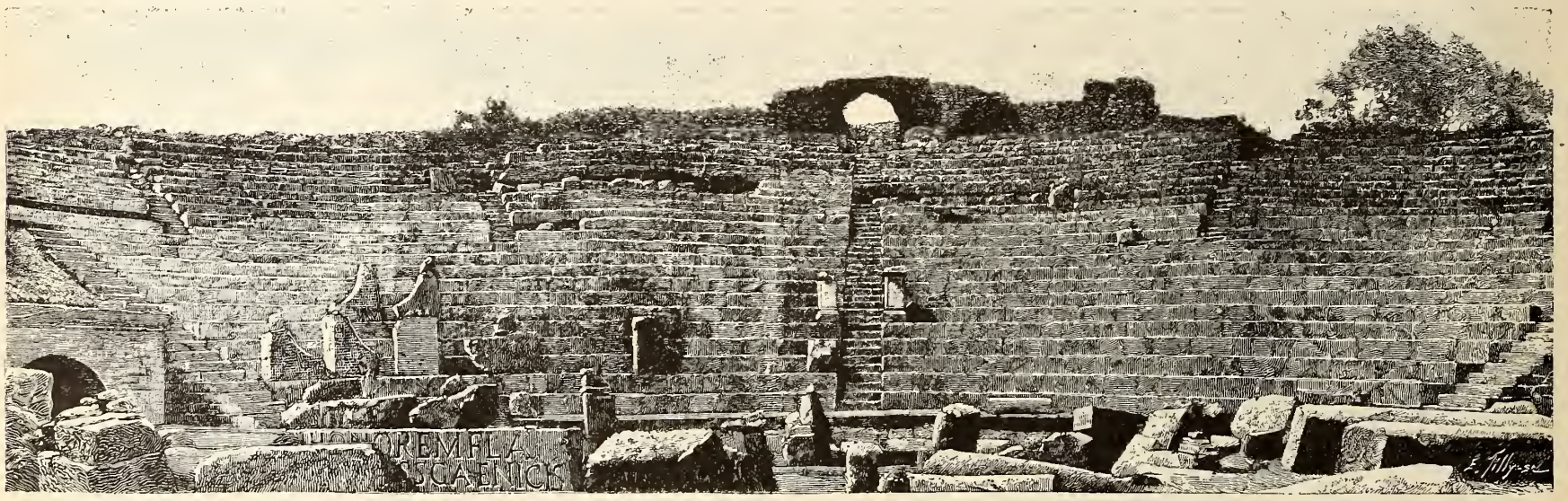
The beautiful sandstone building forms a rectangle about 433 feet long by more than 288 feet wide. From the accompanying engraving a good idea of the style of architecture can be obtained. Square towers extend high above the roof at the four corners, having the effect of corner pillars, and forming a fine contrast to the gilded dome in the center, which is crowned by a richly gilded lantern, a charming little tower, the summit of which carries the imperial crown. On the two visible sides of each of the corner towers there are symbolical statues, figures in sandstone more than 12 feet high, representing the powers of state; those on one tower represent defense by water and by land, the administration of justice and the science of government; those on the second, the ethical element of the civilization of a nation, bringing up of children, education, art and literature; on the third, the sources of food supply, agriculture, cattle breeding, beer and wine; and on the fourth, commerce and industry—the great industries and trade in connection with navigation, electricity, and the small home industries are represented. This colossal work was executed by the sculptors Maison, Volz, Schierholz, Behrens, Lessing, Diez, Eberlein and Eberle. It will be seen that artistic skill has been brought from all parts of the empire to execute the task worthily.

The Koingplatz front, which is really the main front, is divided by half columns, and over the large arched windows of the main floor there are only the windows of one other story. The other fronts are divided by pilasters, and above the windows of the main floor there are windows of two other stories. In the center of each front there is a richly decorated portal, which constitutes its chief architectural beauty.

Over the three doors on the Koingplatz there is a pediment supported on great pillars, and very richly ornamented. Above this pediment will be placed the colossal group of Germania, seated man-fashion on a horse, and accompanied by two heroic figures. The dome forms a fine background for this group, which was modeled by Reinhold Begas and executed in cop-



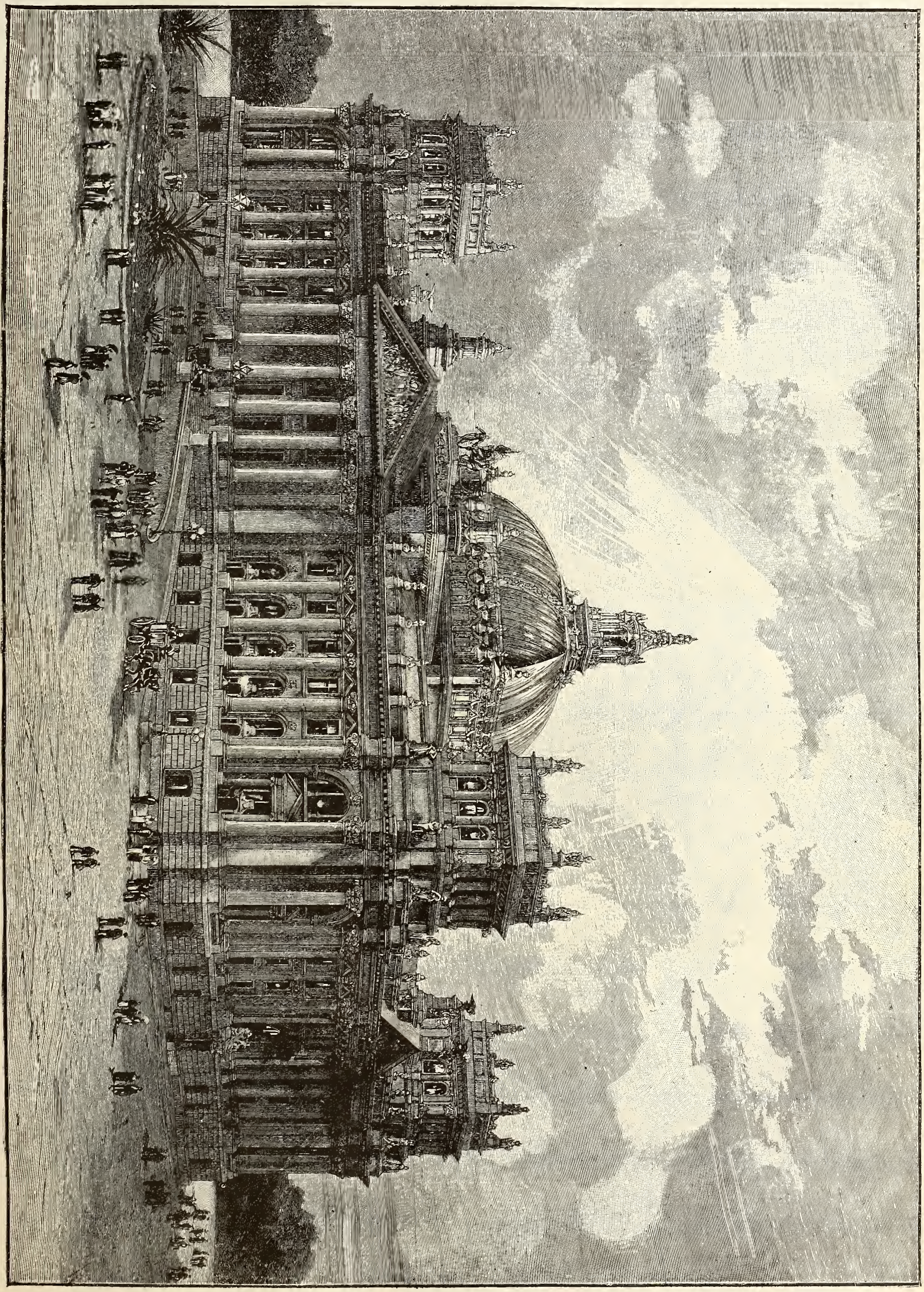
RUINS OF THE ROMAN THEATER AT DOUGGA—THE STAGE.



RUINS OF THE ROMAN THEATER AT DOUGGA—THE CAVEA, OR PART RESERVED FOR THE SPECTATORS.

per by Seitz. It was sent to the Chicago Exposition. On each side of the group there will be pedestals supporting the insignia of the empire chiseled in sandstone. The surface of this pediment is well covered with particularly fine decorations designed by Prof. Schaper and chiseled in sandstone by the sculptor a knight fighting manfully with the dragon "Strife;" higher up an inscription relating to the construction of the building, and in the front wall of the vestibule are to be two genealogical trees modeled by Prof. Lessing and so placed as to be visible between the outer pairs of columns. One of these trees will represent an oak and the other a pine; on the former will be the coat of arms of the North German States and the other that of the South German States. Father Rhein will rest at the foot of the oak, and the personification of the Weichsel at the foot of the pine.

In comparison with the wealth of decoration on this portion, the rest of the front is, of course, very simple, but the colossal heads by Prof. Wiedemann, of Frankfort, on the keystones of the arches over the windows of the main floor are especially fine; being well chosen emblems of the rivers and streams of the Fatherland. The front is completed by the two towers with their



THE NEW GERMAN REICHSTAG BUILDING, BERLIN—WEST (MAIN) FACADE.—PLANS DRAWN BY PAUL WALLOT.

Lock. In the center is a shield bearing the national eagle and protected by two figures of heroic size, and above the shield are the crown and baldachin. On each side is a noble group; one representing art and trade, and on the other, science and agriculture. Inside, above the middle door, will be seen the figure of immense pillars carrying statues, while above all rise groups of boys bearing aloft the imperial crown. The latter were modeled by the sculptor Brutt.

The long front on Sommerstrasse is plainer, but here also the portal is more highly decorated than the rest of the facade. In the three arches, back of which

is the landing leading to the door, will be bronze statues of Bismarck, Moltke and Roon, in sitting postures. High above the middle structure, on pedestals, there will be the colossal figures of two heralds mounted on horseback, waving their banners enthusiastically, and on each of the side walls there will be enormous coats of arms of the German empire accompanied by heroic figures.

The portal on the Koingplatz will be the entrance used on ceremonious occasions, and that on Sommerstrasse will be used by members of the Imperial House and the members of the Bundesrath. The members of the Reichstag will use the entrance in the south front nearest the Brandenburg gate. The fronts facing north and south are the smaller ones. The portals on these sides are also very beautiful, each having a pediment resting on a group of columns, and on the field of the pediment is the German eagle stretching his wings over the four kingdoms symbolized by their coats of arms. On each side of both pediments is a pedestal bearing an eagle that has swooped down on a snake. The fronts of these pedestals are decorated with the initials of Emperor William I. entwined with laurel. Directly above one entrance will be an allegorical group representing "Strength," and over the other a group representing "Wisdom." The effect of these fronts is grand and beautiful.

The artist planned the interior with no less grandeur. Work on this part is being busily pushed forward, because the building is to be ready for occupancy by next fall. A model of the building, prepared by G. Berger, was sent to the Chicago Exposition.—*Illustrirte Zeitung.*

## A CURIOUS PHENOMENON OF ELECTRIFICATION.

Mr. F. Drouin points out a curious phenomenon of electrification that occurs when a gelatinized photo-

graphic print is detached from the glass upon which it has been dried for enameling. The glass becomes so strongly electrified that small sparks can be drawn from it with the hand, that it may be used as an electrophorus plate, and that it will attract light bodies at a distance of three inches.

The best method of performing the experiment is the following: Take a photographic print upon gelatine paper and apply it to glass under water in the same way as for ordinary enameling, and allow it to dry perfectly, that is to say, for twelve or fifteen hours.

The whole is then laid upon two supports (two books, for example), the print upward, and under the glass are placed bits of paper or elder pith. The print is then detached in the usual manner (there is no need at all of operating rapidly), and the light bodies rush under the glass. A carbon print transferred to glass will, when detached, give rise to the same phenomenon. If the print is not doubled, it is found that the thin film of gelatine is strongly attracted to its former place, if it is left to itself during the operation.—*Les Inventions Nouvelles.*

## THE JEFFREY ELECTRIC COAL MINING MACHINE.

In no country in the world is the commercial value of machinery better understood than it is in the United States. There no sentimental feeling prevents the substitution of the machine for a dozen men, when the machine can be had. American capitalists have learned long since that the men will not spare them, and they accordingly dispense with labor as far as in them lies. Just now the coal strike has led English mine owners to see much good in American methods, and Messrs. John Davis & Son, All Saints' Works, Derby, are now introducing the Jeffrey coal cutting machine. It is now, and has been for some time, at work in the Cannock and Rugeley Colliery, where it is holing 4 ft. deep by 3 ft. wide at an average speed of three minutes. The time occupied in resetting the machine is only three or four minutes, so that in straightforward work ten cuts are made per hour, equivalent to 120 square feet per hour. How much coal can be brought down depends on the thickness of the seam; but we are informed that in the United States, where the machine has been at work some years, and where some of the largest collieries are wholly worked by Jeffrey machines, the men contract in thick seams to hew 240 tons of coal per machine in two shifts per day. Furthermore, it is stated that the cost of maintenance and repairs is about three farthings per ton.

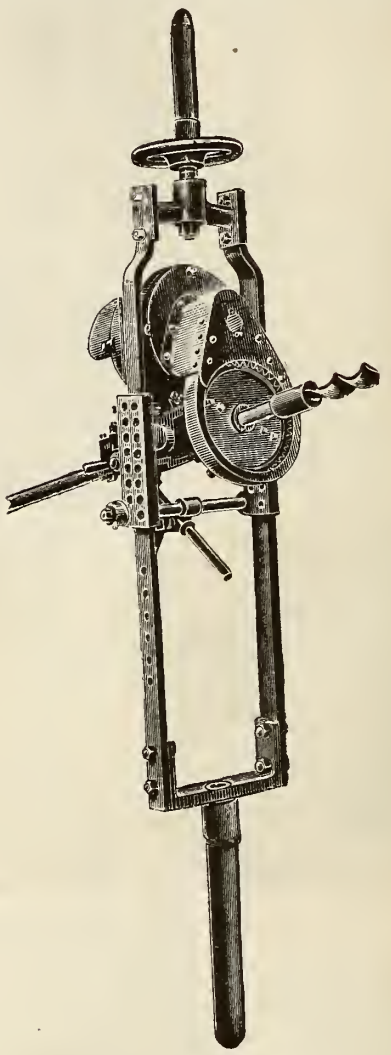
The construction of the machine will be readily understood from our illustrations, which are reproductions of photographs of the Cannock and Rugeley machine. The "holing," or undercutting, is done by a horizontal bar armed with cutting blades, which is seen at the front end of the machine, and is caused to revolve rapidly by endless chains. These chains are driven either by an electric motor or by air engines. The two outside chains are used to remove the coal dust. The bent bar with a hand wheel seen near the end of the machine is not a pick, but a strut, by which the machine is secured in its place, and held up against the thrust set up by the action of the cutter bar.

To go into details, we may say that the machine consists of a bed frame occupying a space 2 ft. wide by 8 ft. 6 in. long, composed of two steel channel bars firmly braced, the top plates on each forming racks with their teeth downward, in which the feed wheels of the sliding frame engage. Mounted upon and engaging with this bed frame is a sliding frame, similarly braced, consisting mainly of two steel bars, upon which are mounted at the rear ends an electric motor, from which power is transmitted through straight gear and a worm wheel to the rack, by means of which the sliding frame is fed forward. Upon the front end of this sliding frame is mounted the cutter bar, held firmly by two solid steel shoes, with suitable brass boxes. The cutter bar is fitted with bits, made of tool steel, held in place by set screws. The cutter bar is caused to revolve by an endless curved link steel chain from the driving shaft, and as it is revolved is advanced by the mechanism into the coal or other material to be undercut to the desired depth. The cutter bar may be driven, as we have said, either by electricity or compressed air.

The electric motor occupies a space about 20 in. square. The current required is from 30 to 50 amperes at a pressure of 220 volts; each motor is wound to develop fully 15 horse power, though frequently in some veins of coal the machine only uses 30 amperes or 7½ horse power in making cuts. The machine is started by means of a switch fixed on a suitable resistance box on the rear end of the motor. The current is gradually turned on by simply passing the lever over buttons. The armature of the motor is calculated to run at a speed of 1,000 revolutions per minute, from which the speed is reduced, so as to run the cutter bar 200 revolutions per minute. The momentum of the armature is such that ordinary obstructions met by the cutter bar in the coal are not perceptible, and the machine runs steadily and comparatively quietly. The machines are run by two men, one man in charge and the other as helper. Trucks are furnished with the machines, so that they can be handled with ease. The machine is taken into the mine upon this truck, and run into the room to be undercut; it is then placed on two boards in front of the coal at one side of the room, and fastened firmly by means of the front and rear jacks, which are braced against the face and roof of the coal; this prevents the machine from moving while in operation; the power is then turned on by the machine runner, and the machine proceeds to its work.

The cutter, which is revolved by an endless chain, is fed forward by means of the rack-and-pinion wheels to a depth of 5 ft. or 6 ft., according to the size of the machine; the usual length of the cutter bar is 39 in. and 42 in., and when the full depth has been reached the feed is thrown off, and by means of a reverse lever the cutter bar is withdrawn to its starting place. This completes the cut, and the machine is moved over the length of the cutter bar used, and another cut is made in the same manner. Thus the work is continued until the entire width of the room has been undercut, after which the machine is again loaded on the truck and taken into another room. These cuts are made on an average of from four to six minutes each. The amount of coal undercut, or the lineal feet face for each machine, depends upon the quality of the coal and the skill of the men handling the machines. In some coal veins the machines have cut at the rate of 130 and 150 lineal feet face in ten hours to a depth of 6 ft. Twice this amount can be cut if the machines are run on double shift. The construction is very simple, so that any person of ordinary intelligence can understand and handle it with a few days' instructions.

When compressed air is used, the electric motor is replaced by a double cylinder engine, with cylinders 5 in. diameter and 5½ in. stroke. In other respects both machines are alike. We may add that the coal

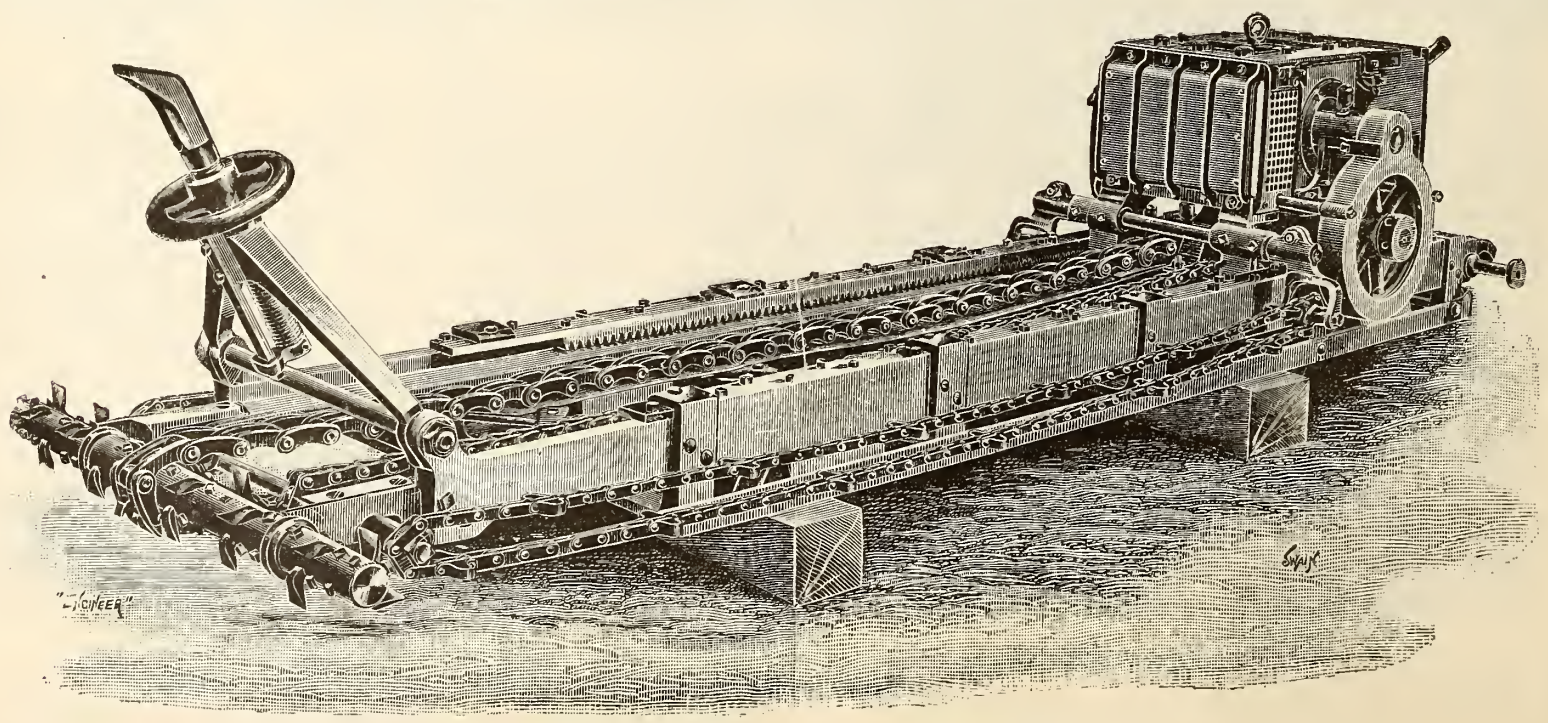


ELECTRIC COAL DRILL.

cutter is made in two sizes, one stronger, heavier, and capable of doing more work than the other.

We also illustrate a drill for blasting in mines, the construction of which will be understood at a glance. This drill has a small electric motor hung in an upright frame, having projections at top and bottom, arranged with adjusting screws by means of which it is fastened to the roof and floor of the mine. This is supported by a brace to stiffen and hold the frame rigid while the drill is in operation, although in low veins, with short posts, this brace would not be needed.

The motor is of the iron-clad type, and will develop 1½ horse power at a pressure of 220 volts, but can be wound for a lower or higher voltage to suit plants already installed. The working parts, including the field coils and armature, are inclosed, with the exception of the commutator brush holders and terminal con-



ELECTRIC COAL CUTTING MACHINE.

nectors, the latter being covered by a sheet iron hood, thus preventing dirt and pieces of coal from damaging the armature and field coils. There are but few parts to the motor, and these are easily replaced. The armature and field coils are insulated in the best manner, and all danger of a burned or grounded coil is, it is claimed, obviated. The motor is not incumbered with a starting resistance or rheostat, as one is not required. The auger runs at about 300 revolutions per minute, and bores a 2 in. hole 6 ft. deep in from two to four minutes.

It will be understood that none of these machines are new and untried. They are, we believe, quite new in this country, but they are well-known in the States, and the Jeffrey Manufacturing Company, Columbus, Ohio, is a large and well established company, which has made mining machinery of all kinds a specialty for many years. The first Jeffrey machine put to work in this country was started in November last. In the United States it is said to have reduced the cost of sending coal to bank to 3s. per ton—a very important fact, considering what wages are in the States.

It would be quite superfluous to point out the advantages of machine holing over hand work; all mine owners and engineers recognize that. The difficulty has lain hitherto in getting a machine to do the work. So far as can be seen, the Jeffrey machine solves the problem, and we hope it will, in the long run, settle the question of machine holing.—*The Engineer, London.*

## ELECTRIC TRANSFER TABLE.

WE illustrate below a very fine electrically driven transfer table, constructed at the Industrial Works, Bay City, Michigan, U.S.A.

The table has a length of 70 ft., and is supported upon sixteen chilled tread wheels, each 36 in. in diameter, 4 in. flat treads, and ground accurately to this diameter. Upon either side of the supporting wheels are placed in pairs 15 in. I beams. To these cross

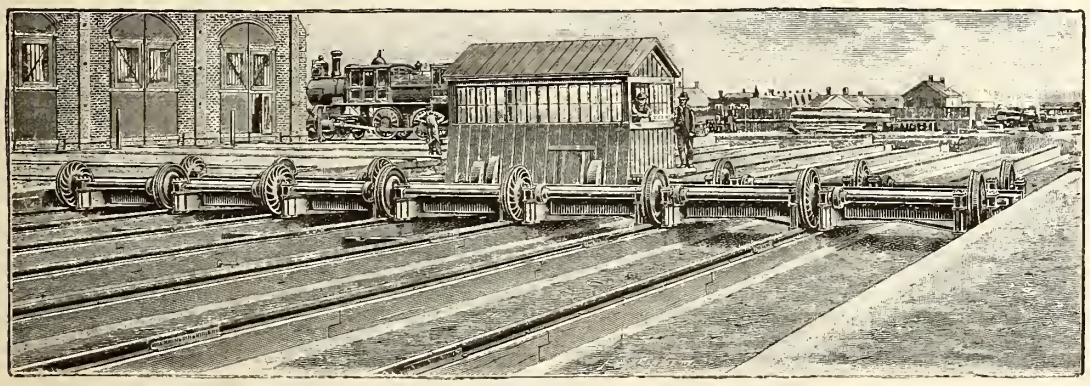


FIG. 1.

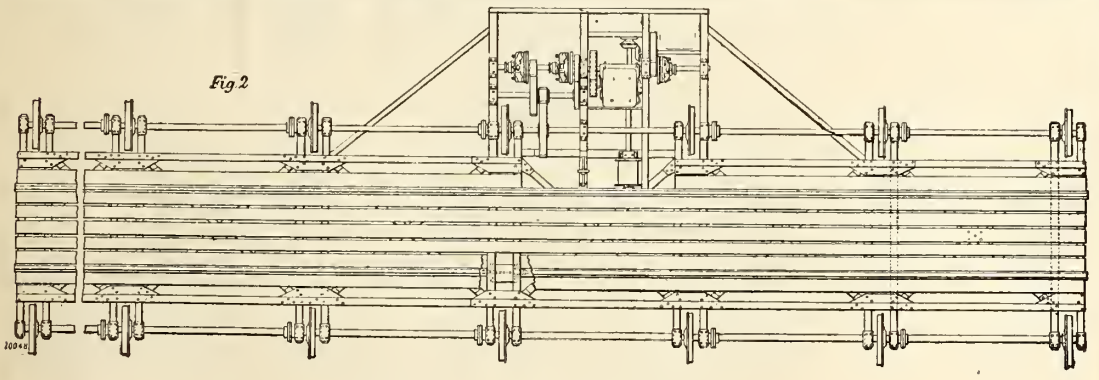


Fig. 2

ELECTRIC TRANSFER TABLE.

beams are riveted the longitudinal beams to which the track is fastened. The framework of the table is of a design to carry 110 tons distributed over a distance of 64 ft.

Necessary power for the propulsion of this table, with two speeds for minimum and maximum loads and for drum attachment for pulling cars on and off, is supplied by an electric motor of 35 horse power, placed as shown. All the motions are transmitted to the longitudinal shaft, either in a forward or reverse direction, by friction clutches. Through these means, without stopping the motor, a minimum speed of 90 ft. per minute for maximum loads may be given, and a maximum speed of 250 ft. for light loads.

A very similar transfer table was installed in the Transportation building of the World's Columbian Exposition of 1893, and was placed in service during the month of December, 1892. From that time until June 5, 1893, it was used continuously, and much of the time, night and day, in placing the heaviest locomotives, cars, and exhibits in the Transportation building. This table moved with ease and dispatch the heaviest locomotive exhibits, weighing 110 tons. The total weight of exhibits handled by it was 51,275,000 pounds.—*Engineering.*

## EFFECT OF ELECTRICITY ON STEAM.

AT a recent meeting of the Royal Society of Great Britain J. J. Thomson described the following experiment, showing the effect of electricity on steam: A current of steam was passed through the middle limb of a T-tube, the closed side limbs of which were furnished with delivery tubes and also with gold or platinum electrodes, between which sparks might be passed through the steam. The delivery tubes conducted the gases into two eudiometers, in which the gaseous mixture formed on passage of the sparks was exploded. When the sparks were from 1·5 to 4 millimeters long it was observed that within the limit of error of the experiment the volumes of the excess of hydrogen in the one tube and of oxygen in the other, which remain after the explosion of the mixed gases, are respectively equal to the volumes of the hydrogen and oxygen liberated in a water voltmeter placed in series with the steam tube, and that the excess of hydrogen appears in the tube which is in connection with the positive electrode, the excess of oxygen in the tube which is in connection with the negative electrode. When the spark length is greater than 4 millimeters, the first of the preceding results ceases to hold, and when the spark length is increased to over 11 millimeters, the excess of hydrogen, instead of appearing at the positive electrode, changes over to the negative, the excess of oxygen at the same time going over from the negative to the positive electrode. When the sparks are very much longer, about 22 millimeters, reversal again takes place, the hydrogen appearing at the positive electrode. The author finds that when the arc discharge passes through hydrogen and oxygen respectively, the hydrogen behaves as if it had a negative charge and the oxygen as if it had a positive one.

## ELECTRO-CHEMICAL EFFECTS ON MAGNETIZING IRON.*

By THOMAS ANDREWS, F.R.SS.L. and E.

### EXPERIMENTS WITH MAGNETIC POLAR TERMINALS.

IN course of an earlier part of this research, the author made many preliminary experiments to investigate the possible electro-chemical effect between the polished end disks or alternate polar terminals of straight round steel magnets when immersed as elements in some electrolytes, only the north and south terminal planes of each steel magnet being simultaneously exposed to the action of the electrolyte.

Indications were afforded, under certain conditions, of a tendency on the part of the N. terminal of the magnet to become from some cause electro-positive to the S. terminal plane.

The magnets were placed parallel at some distance apart in an upright position, the lower end of each magnet, exposed in the solution, was covered with black India rubber tubing, so that the flat polished terminal disks only were exposed to the action of the electrolyte. The bars used for the magnets were of polished steel, 4¼ inches long, $\frac{5}{16}$ inch diameter, cut adjacently, previous to magnetization, from a longer bar. A pair of magnets were securely placed in a wooden frame, and the N. and S. terminals of each bar immersed in the solution placed below. A number of experiments were made with the arrangement, and with a galvanometer in circuit, using a pair of new steel magnets each time. In these observations the current appeared to flow from the N. to the S. polar terminal; care was exercised to insure that the magnets were as near as practicable equally magnetized.

The indications of the apparent tendency of the N. pole to become electro-positive in an electrolyte appeared somewhat singular, and after communicating these preliminary results to Prof. G. G. Stokes, and conferring with him thereon, it was decided to make further experiments, and in course of these I have endeavored to utilize some valuable experimental suggestions which Prof. Stokes kindly made.

Prof. Stokes suggested that the results noticed in the first set of experiments might probably be accounted for in the following manner, thus: Supposing the bars to be equally magnetized permanently, then when the magnet bars were placed in the upright position the magnetism induced in the bars by the earth's magnetic force would in one magnet strengthen and in the other oppose the permanent magnetism, so that the stronger pole would be the N. one at the bottom. To investigate this possible aspect of the matter, an apparatus was constructed with which to conduct the further investigations. The arrangement consisted of a wooden stand, the thick upper crossbar of which was hollow and formed a tank sufficiently capacious to hold a suitable quantity of the electrolyte. The ends of two magnetized steel bars were securely inserted from below through the two holes in the bottom, so that the upper terminal disks only of the magnets were exposed to the solution. These holes were very accurately and carefully drilled, and when the bars were forced in, the arrangement was quite fluid tight, and the greatest care was exercised to insure that the terminal planes only of the magnets were exposed to the action of the solution. The steel rods were connected with a galvanometer which was introduced into the circuit, and the electrolyte was then poured into the upper receptacle and the readings of galvanometer noted. A new wooden stand was prepared for each experiment, and a new pair of steel magnets was also employed for each observation. In many experiments the electrolyte was first introduced to the lower ends of the bars, and observations first taken of the relative electro-chemical positions of the N. and S. terminals at the lower end of the magnets. The solution was afterward removed, the lower bar ends cleaned, and the electrolyte subsequently placed in the upper receptacle. By this means an indication of the relative electro-chemical position of both the upper and lower polar disks of the same pair of steel magnets was afforded.

In course of the investigations it was frequently noticed that an instantaneous fling of the galvanometer occurred on first immersing the bars in the electrolyte, the fling showing the S. polar terminal to be positive at the moment of commencing the experiment; this instantaneous fling of the galvanometer very rapidly subsided, and the subsequent readings showed a continuously steady positive position for the N. pole. It will also be generally noticed that the E M. F. steadily increased from the commencement of an experiment, when the electrolyte was placed either above or below the magnets, the polar influence appearing gradually and increasingly to affect the action taking place. An examination of the results of the total observations, on the steel magnets, in which the electrolyte (cupric chloride solution) was placed below the magnets, gave an average E. M. F. of 0·014 volt; whereas the observations made with the electrolyte above the magnets yielded an average E. M. F. of 0·011 volt. Further experiments were also confirmatory of this difference in the extent of E. M. F.

The general results seem, therefore, to indicate that the positivity of the upper N. polar terminal was reduced relatively to some extent when the electrolyte was placed above the magnets, and this circumstance may possibly be owing to the action of the upper N. pole having been comparatively weakened by the influence of the earth's magnetism, as suggested by Prof. Stokes. This difference, ascertained from the results of such a considerable number of observations, in the extent of the E. M. F. may perhaps thus be accounted for. It will be seen that the united results lead to the tentative conclusion that there was a general tendency, under the conditions of experimentation, on the part of the N. magnetic terminal of the steel magnets to assume electro-chemically the positive position compared with the S. terminal, when these constituted elements in certain electrolytes. The result was seemingly due to the magnetic poles diversely influencing the action of the solution on the metal; and in the case of the copper salts the ratio of the electro-deposition of the copper was apparently affected by these magnetic influences.

* Abstract of paper in the *Proceedings* of the Royal Society.

## STRENGTH LOST BY THE TWIST.

ACCORDING to experimental research, it appears that we can only obtain about 30 per cent. of the total amount of fibers composing a thread of any given size. This verdict gives one a strong desire to refute it. When we consider the degree of perfection to which we have brought all our cotton machinery, the actual intelligence displayed by the various movements, the sensitiveness exhibited in the manipulation of the fibers, from the raw condition, through each process, converging and placing the fibers in closer contact in order to fit them to withstand the strain to which they will be subjected when they finally arrive at the point where size, cleanliness and order show they are suitable for the twist which is to bind them into one, and then to find that, with all our care and skill, as soon as the association is formed, instead of adding to the strength of the fibers, we have really taken away some 70 per cent., is to depart forever from the old saying that "Union is strength."

If we take a cross section of a thread of any counts, numbering the fibers and multiplying the weight that one of them will sustain without breaking by the total number of fibers, the aggregate strength should result; but this is only the theoretical strength, because we take it for granted that each fiber has the same amount of resistance or degree of strength. Now, this is a fallacy. Fibers are neither of the same length nor diameter, nor, in fact, of the same matured condition in growth in the same pod. This determines the tensile properties of individual fibers, but the question is why do we not get a higher percentage of strength in our yarns? Well, if we notice how fibers are combined and twisted round one another through their entire length, we are convinced that they suffer some alteration in their structure. All fibers are not completely and securely entwined throughout their entire length, and, owing to the manner of union as a thread, their tenacity cannot be as great as it would be if more intermingling could be adopted, similar to braiding them together.

The point of resistance when a strain is applied is not at the extremity of each fiber, as when tested separately, where each fiber merely sustains its own weight. In a thread some of this resisting power is spent in direct opposition to each other, thus weakening and lessening their united strength. If the fibers are straight, as they are when separate, the elasticity is complete, but in the thread this is not the case, because all do not stretch alike; some become ruptured sooner than they would if the rest possessed more elasticity, that is in a cross section at that point. It may be said further that all fibers at the point of rupture do not break at once, and some not at all, but simply pull away from the rest, and here we fail to realize what would remedy this great deficiency, for if we twist them so that they shall all break at once we shall be in a worse plight than before. In any and every case excessive twist will diminish the strength of any thread however spun.

What we have said about the great disparity between the actual and theoretical strength of yarns may be of some value to students and operatives. The

loss is not due to our neglect or incompetency as spinners, but to an inevitable combination of circumstances, although an increase of strength might be obtainable, but for the pernicious custom adopted of putting in too much twist. A very inferior staple is so twisted to make it adhere together, but the yarn is trashy and unfit for any fabric but the very lowest that can be woven.

The constant twist factor, whether it be 3·25 or 4, or any other figure, is not to be depended upon; in fact, spinners of well-known ability alter according to the fiber they have to contend with—the only use of the factor is as a mere guide. Too much twist is loss to spinners, and, in a woven fabric, in place of increasing the strength of the cloth, whether used as warp or weft, its tendency is to weaken it to a great extent. The extremes are carried out both ways, and the reason for this is that there is and always has been a diversity of opinion. One advocates plenty of twist, another a medium amount, while a third declares he cannot sell any yarns except those that are soft twisted.—*Textile Industries.*

[FROM THE AMERICAN JOURNAL OF SCIENCE.]

## THE INTERNAL WORK OF THE WIND.*

By S. P. LANGLEY.

### PART I.—INTRODUCTORY.

IT has long been observed that certain species of birds maintain themselves indefinitely in the air by "soaring," without any flapping of the wing or any motion other than a slight rocking of the body; and this, although the body in question is many hundred times denser than the air in which it seems to float with an undulating movement, as on the waves of an invisible stream.

No satisfactory mechanical explanation of this anomaly has been given, and none would be offered in this connection by the writer, were he not satisfied that it involves much more than an ornithological problem, and that it points to novel conclusions of mechanical and utilitarian importance. They are paradoxical at first sight, since they imply that under certain specified conditions very heavy bodies entirely detached from the earth, immersed in and free to move in the air, can be sustained therein indefinitely, without any expenditure of energy from within.

These bodies may be entirely of mechanical construction, as will be seen later, but for the present we will continue to consider the character of the invisible support of the soaring bird, and to study its motions, though only as a pregnant instance offered by nature to show that a rational solution of the mechanical problem is possible.

Recurring, then, to the illustration just referred to, we may observe that the flow of an ordinary river would afford no explanation of the fact that nearly inert creatures, while free to move, although greatly denser than the fluid, yet float upon it; which is what we actually behold in the aerial stream, since the writer, like others, has satisfied himself by repeated observations that the soaring vultures and other birds appear as if sustained by some invisible support in the stream of air, sometimes for at least a considerable fraction of an hour. It is frequently suggested by those who know these facts only from books that there must be some quivering of the wings, so rapid as to escape observation. Those who do know them from observation are aware that it is absolutely certain that nothing of the kind takes place, and that the birds sustain themselves on pinions which are quite rigid and motionless, except for a rocking or balancing movement involving little energy.

The writer desires to acknowledge his indebtedness to that most conscientious observer, M. Mouillard,* who has described these actions of the soaring birds with incomparable vividness and minuteness, and who asserts that they under certain circumstances, without flapping their wings, rise and actually advance against the wind.

To the writer, who has himself been attracted from his earliest years to the mystery which has surrounded this action of the soaring bird, it has been a subject of continual surprise that it has attracted so little attention from physicists. That nearly inert bodies, weighing from 5 to 10, and even more, pounds, and many hundred times denser than the air, should be visibly suspended in it above our heads, sometimes for hours at a time, and without falling—this, it might seem, is, without misuse of language, to be called a physical miracle; and yet the fact that those whose province it is to investigate nature have hitherto seldom thought it deserving attention is perhaps the greater wonder.

This indifference may be in some measure explained by the fact that the largest and best soarers are of the vulture kind, and that their most striking evolutions are not to be seen in those regions of the northern temperate zone where the majority of those whose training fits them to study the subject are found. Even in Washington, however, where the writer at prese t re-

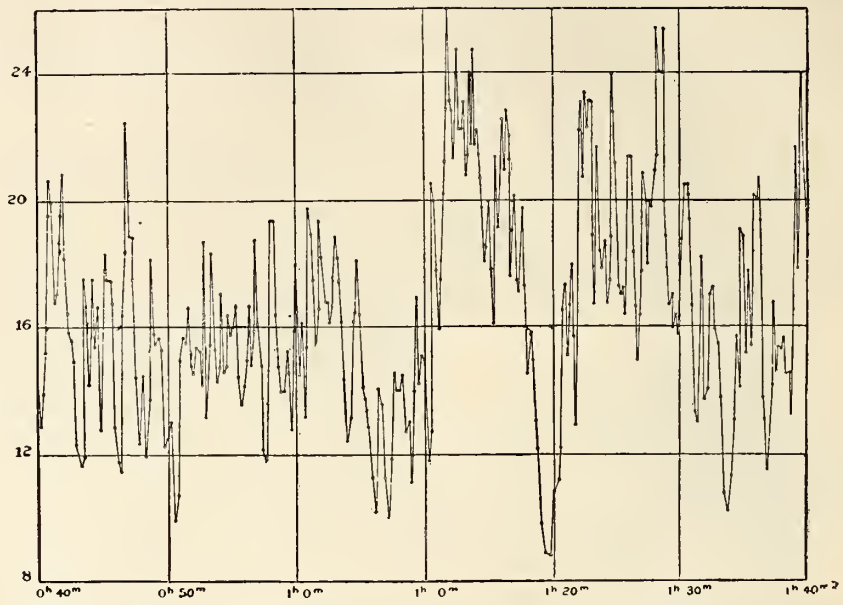



FIG. 1.—Wind velocities recorded July 16, 1887, at the Allegheny Observatory, with a Robinson anemometer registering every 25 revolutions.
Abscissae = time. Ordinates = wind velocities in miles per hour.

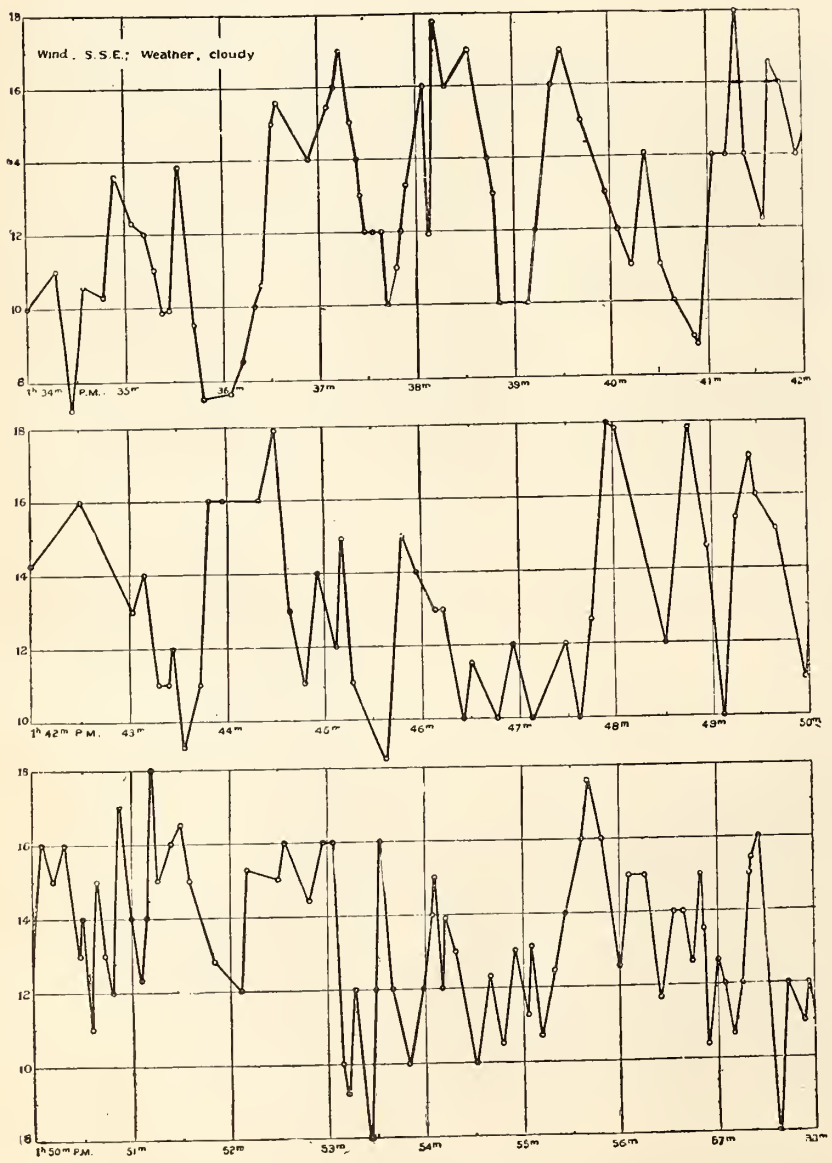



FIG. 2.—Wind velocities recorded January 14, 1893, at the Smithsonian Institution, with a light Robinson anemometer (paper cups) registering every revolution.
Abscissae = time. Ordinates = wind velocities in miles per hour.

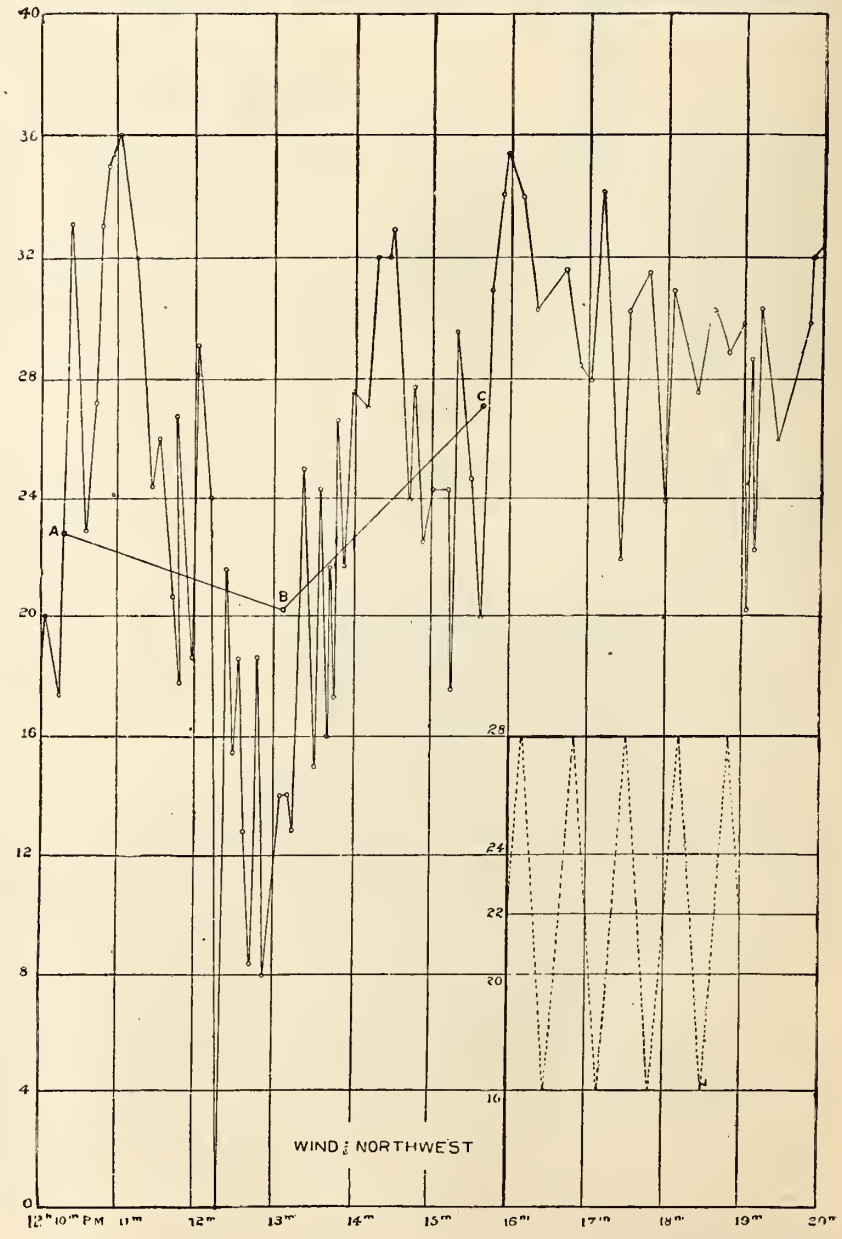



FIG. 3.—Wind velocities recorded February 4, 1893, at the Smithsonian Institution, with a light Robinson anemometer (paper cups) registering every revolution.
Abscissae = time. Ordinates = wind velocities in miles per hour.

* A paper read (by title only) to the National Academy of Sciences, in April, 1893, and subsequently (in full) at the Aeronautical Congress, at Chicago, in August, 1893.

* L. P. Mouillard, "L'Empire de l'Air." Paris, G. Masson.

sides, scores of great birds may be seen at times in the air together, gliding with and against the wind, and ascending higher at pleasure, on nearly motionless wings. "Those who have not seen it," says M. Mouillard, "when they are told of this ascension without the expenditure of energy, are always ready to say, 'but there must have been movements, though you did not see them;'" "and in fact," he adds, "the casual witness of a single instance, himself, on reflection, feels almost a doubt as to the evidence of his senses, when they testify to things so extraordinary."

Quite agreeing with this, the writer will not attempt any general description of his own observations, but as an illustration of what can sometimes be seen, will give a single one, to whose exactness he can personally witness. The common "turkey buzzard" (*Cathartes aura*) is so plenty around the environs of Washington that there is rarely a time when some of them may not be seen in the sky, gliding in curves over some attractive point, or, more rarely, moving in nearly straight lines on rigid wings, if there be a moderate wind. On the only occasion when the motion of one near at hand could be studied in a very high wind, the author was crossing the long "Aqueduct Bridge" over the Potomac, in an unusually violent November gale, the velocity of the wind being probably over 35 miles an hour. About one-third of the distance from the right bank of the river, and immediately over the right parapet of the bridge, at a height of not over 20 yards, was one of these buzzards, which, for some object which was not evident, chose to keep over this spot, where the gale, undisturbed by any surface irregularities, swept directly up the river with unchecked violence. In this aerial torrent, and apparently indifferent to it, the bird hung, gliding in the usual manner of its species, round and round, in a small oval curve, whose major axis (which seemed toward the wind) was not longer than twice its height from the water. The bird was therefore at all times in close view. It swung around repeatedly, rising and falling slightly in its course, while keeping, as a whole, on one level, and ov r the same place, moving with a slight swaying, both in front and lateral direction, but in such an effortless way as suggested a lazy yielding of itself to the rocking of some invisible wave.

It may be asserted that there was not only no flap of the wings, but not the quiver of a wing feather visible to the closest scrutiny, during the considerable time the bird was under observation, and during which the gale continued. A record of this time was not kept, but it at any rate lasted until the writer, chilled by the cold blast, gave up watching and moved away, leaving the bird still floating about, at the same height in the torrent of air, in nearly the same circle, and with the same aspect of indolent repose.

If the wind is such a body as it is commonly supposed to be, it is absolutely impossible that this sustention could have taken place in a horizontal current any more than in a calm, and yet that the ability to soar is in some way connected with the presence of the wind became to the writer as certain as any fact of observation could be, and at first the difficulty of reconciling such facts (to him undoubted) with accepted laws of motion seemed quite insuperable.

Light came to him through one of those accidents which are commonly found to occur when the mind is intent on a particular subject, and looking everywhere for a clew to its solution.

In 1887, while engaged with the "whirling table" in the open air at the Allegheny Observatory, he had chosen a quiet afternoon for certain experiments, but in the absence of the entire calm which is almost never realized, had placed one of the very small and light anemometers made for hospital use in the open air, with the object of determining and allowing for the velocity of what breeze existed. His attention was called to the extreme irregularity of this register, and he assumed at first that the day was more unfavorable than he had supposed. Subsequent observations, however, showed that when the anemometer was sufficiently light and devoid of inertia, the register always showed great irregularity, especially when its movements were noted, not from minute to minute, but from second to second.

His attention once aroused to these anomalies, he was led to reflect upon their extraordinary importance in a possible mechanical application. He then designed certain special apparatus herafter described, and made observations with it which showed that "wind" in general was not commonly what it was assumed to be, that is, air put in motion with an approximately uniform velocity in the same strata; but that, considered in the narrowest practicable sections, wind was always not only not approximately uniform, but variable and irregular in its movements beyond anything which had been anticipated, so that it seemed probable that the very smallest part observable could not be treated as approximately homogeneous, but that even here there was an internal motion to be considered, distinct both from that of the whole body and from its immediate surroundings. It seemed to the writer to follow as a necessary consequence that there might be a potentiality of what may be called "internal work"* in the wind.

On further study, it seemed to him that this internal work might conceivably be so utilized as to furnish a power which should not only keep an inert body from falling, but cause it to rise, and that while this power was the probable cause of the action of the soaring bird, it might be possible through its means to cause any suitably disposed body, animate or inanimate, wholly immersed in the wind, and wholly free to move, to advance against the direction of the wind itself. By this it is not meant that the writer then devised means for doing this, but that he then attained the conviction both that such an action involved no contradiction of the laws of motion and that it was mechanically possible (however difficult it might be to realize the exact mechanism by which this might be accomplished).

It will be observed that in what has preceded it is intimated that the difficulties in the way of regarding this even in the light of a theoretical possibility may have proceeded, with others as with the writer, not from erroneous reasoning, but from an error in the premises, entering insidiously in the form of the tacit assumption made by nearly all writers, that the word "wind" means something so simple, so readily intelligible, and so commonly understood as to require no special definition; while, nevertheless, the observations which are presently to be given show that it is, on the contrary, to be considered as a generic name for a series of infinitely complex and little known phenomena.

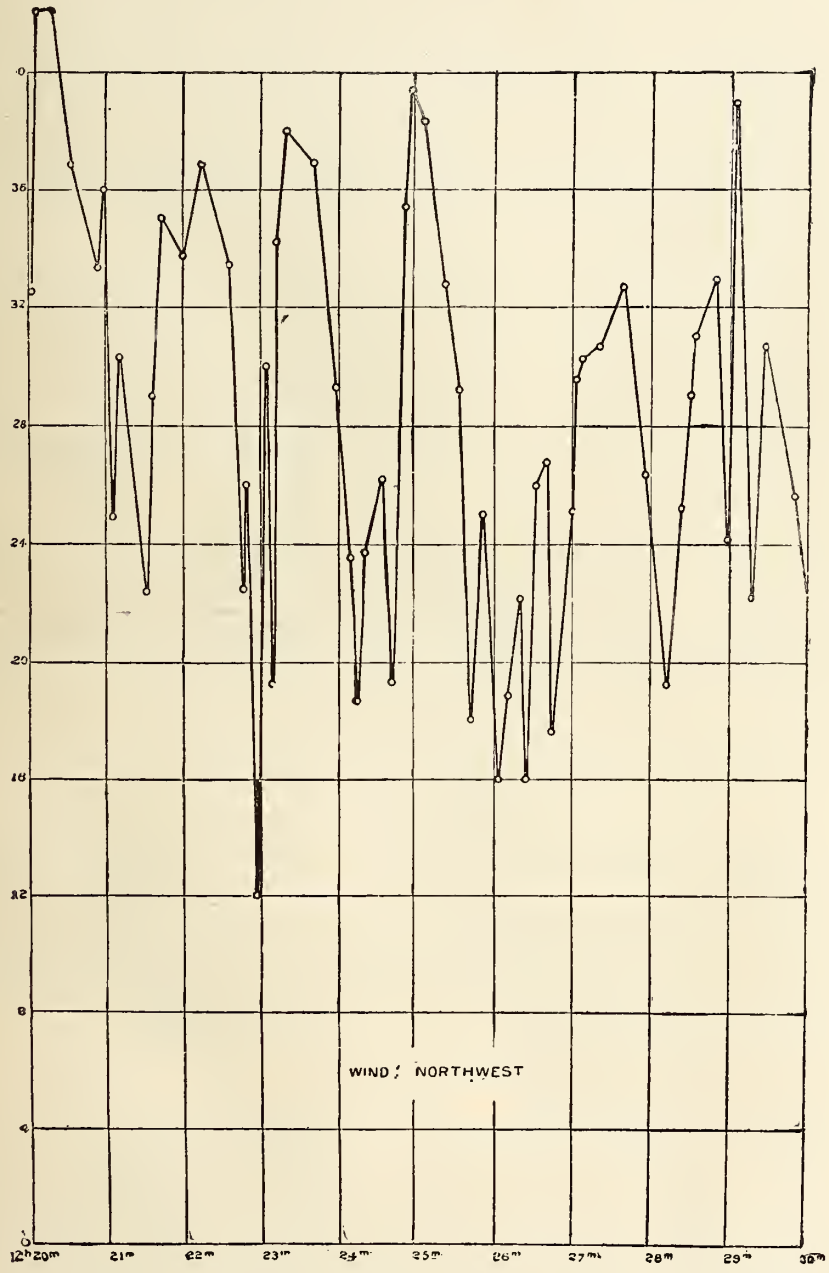



FIG. 4.—Wind velocities recorded February 4, 1893, at the Smithsonian Institution, with a light Robinson anemometer (paper cups) registering every revolution. Abscissae = time. Ordinates = wind velocities in miles per hour.

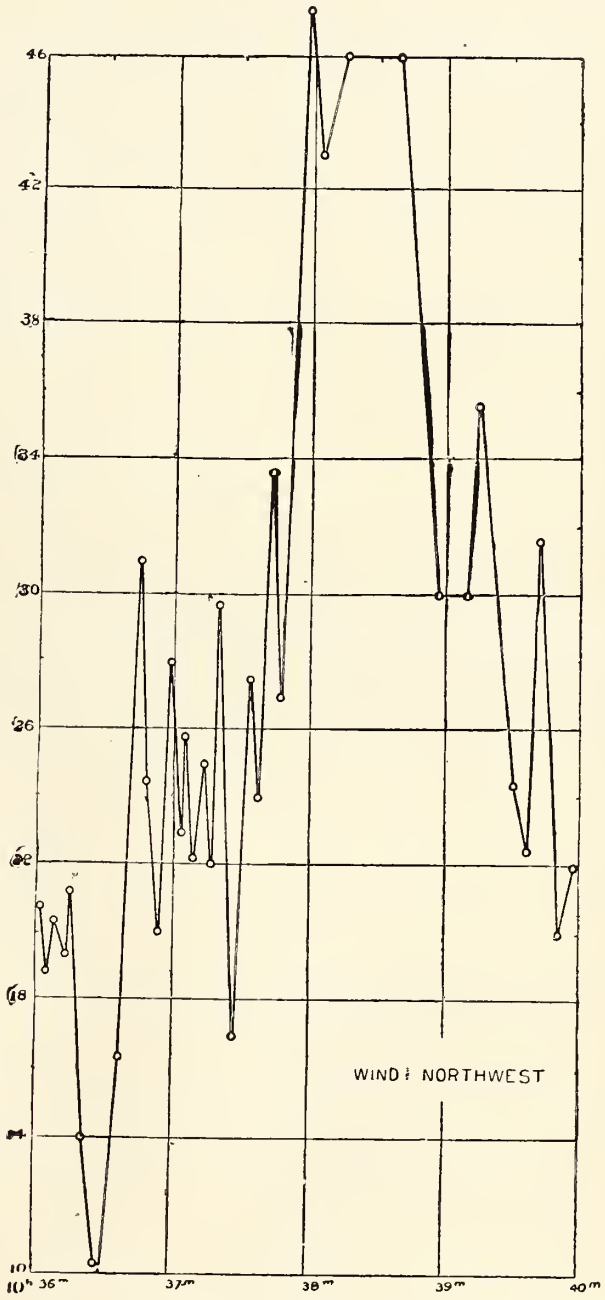



FIG. 5.—Wind velocities observed at Smithsonian Institution, February 20, 1893, with a Robinson anemometer (aluminum cups) registering every five revolutions. Abscissae = time. Ordinates = wind velocities in miles per hour.

* Since the term "internal work" is often nsed in thermo-dynamics to signify molecular action, it may be well to observe that it here refers not to molecular movements, but to pulsations of sensible magnitude, always existing in the wind, as will be shown later, and whosc extent and extraordinary possible mechanical importance it is the object of this research to illustrate. The term is so significant of the author's meaning that he permits himself the use of it here, in spite of the possible ambiguity.

Without determining here whether any mechanism can be actually devised which shall draw from the wind the power to cause a body wholly immersed in it to go against the wind, the reader's consideration is now first invited to the evidence that there is no contradiction to the known laws of motion, and at any rate no theoretical impossibility in the conception of such a mechanism, if it is admitted that the wind is not what it has been ordinarily taken to be, but what the following observations show that it is.

What immediately follows is an account of evidence of the complex nature of the "wind," of its internal movements, of the resulting potentiality of this internal work, and of attempts which the writer has made to determine quantitatively its amount by the use of special apparatus, recording the changes which go on (so to speak) *within* the wind in very brief intervals. These results may, it is hoped, be of interest to meteorologists, but they are given here with special reference to their important bearing on the future of what the writer has ventured to call the science of aerodromics.*

* From ἀ'εροδρομεεω, to traverse the air; ἀ'εροδρομος, an air runner.

The observations which are first given were made in 1887 at Allegheny and are supplemented by others made at Washington in the present year.*

What has just been said about their possible importance will perhaps seem justified, if it is remarked (in anticipation of what follows later) that the result of the present discussion implies not only the theoretical, but the mechanical possibility, that a heavy body wholly immersed in the air and sustained by it, may, without the ordinary use of wind, or sail, or steam, and without the expenditure of any power except such as may be derived from the ordinary winds, make an aerial voyage in any direction, whose length is only limited by the occurrence of a calm. A ship is able to go against a head wind by the force of that wind, owing to the fact that it is partly immersed in the water, which reacts on the keel, but it is here asserted that (contrary to usual opinion and in opposition to what at first may seem the teachings of physical science) it is not impossible that a heavy and nearly inert body *wholly* immersed in the air can be made to do this.

The observations on which the writer's belief in this mechanical possibility are founded will now be given.

### PART II.—EXPERIMENTS WITH THE USE OF SPECIAL APPARATUS.

In the ordinary uses of the anemometer—let us suppose it to be a Robinson's anemometer, for illustration—the registry is seldom taken as often as once a minute; thus, in the ordinary practice of the United States Weather Bureau, the registration is made at the passage of each mile of wind. If there be very rapid fluctuations of the wind, it is obviously desirable, in order to detect them, to observe the instrument at very brief intervals, *e. g.*, at least every second, instead of every minute or every hour, and it is equally obvious that in order to take up and indicate the changes which occur in these brief intervals, the instrument should have as little inertia as possible, its momentum tending to falsify the facts by rendering the record more uniform than would otherwise be the case.

In 1887 I made use of the only apparatus at command—an ordinary small Robinson's anemometer, having cups 3 inches (7·5 cm.) in diameter, the center of the cups being 6¾ inches (16¼ cm.) from the center of rotation. This was placed at the top of a mast 53 feet (16·2 meters) in height, which was planted in the grounds of the Allegheny Observatory, on the flat summit of a hill which rises nearly 400 feet (122 meters) above the valley of the Ohio River. It was, accordingly, in a situation exceptionally free from those irregularities of the wind which are introduced by the presence of trees and of houses or of inequalities of surface.

Every twenty-fifth revolution of the cups was registered by closing an electric circuit, and the registry was made on the chronograph of the observatory by a suitable electric connection, and these chronograph sheets were measured and the results tabulated. A portion of the record obtained on July 16, 1887, is given on Fig. 1, the abscissæ representing time and the ordinates wind velocities. The observed points represent the wind's velocities as computed from the intervals between each successive electrical contact, as measured on the chronograph sheets, and for convenience in following the succession of observed points they are here joined by straight lines, though it is hardly necessary to remark that the change in velocity is in fact, though quite sharp, yet not in general discontinuous, and the straight lines here used for convenience do not imply that the rate of change of velocity is uniform.

The wind velocities during this period of observation ranged from about 10 to 25 miles an hour, and the frequency of measurement was every 7 to 17 seconds. If, on the one hand, owing to the weight and inertia of the anemometer, this is far from doing justice to the actual irregularities of the wind; on the other, it equally shows that the wind was far from being a body of even approximate uniformity of motion, and that even when considered in quite small sections, the motion was found to be irregular almost beyond conception—certainly beyond anticipation; for this record is not selected to represent an extraordinary breeze, but the normal movement of an ordinary one.

By an application of these facts, to be presented later, I then reached by these experiments the conclusion that it was theoretically possible to cause a heavy body wholly immersed in the wind to be driven in the opposite direction, *e. g.*, to move east while the wind was blowing west, without the use of any power other than that which the wind itself furnished, and this even by the use of plane surfaces, and without taking advantage of the more advantageous properties of curved ones.

This power, I further already believed myself warranted by these experiments in saying, could be obtained by the movements of the air in the horizontal plane alone, even without the utilization of currents having an upward trend. But I was obliged to turn to other occupations, and did not resume these interesting observations until the year 1893.

Although the anemometer used at Allegheny served to illustrate the essential fact of the rapid and continuous fluctuations of even the ordinary and comparatively uniform wind, yet owing to the inertia of the arms and cups, which tended to equalize the rate (the moment of inertia was approximately 40,000 gr. cm.$^2$) and to the fact that the record was only made at every twenty-fifth revolution, the internal changes in the horizontal component of the wind's motion, thus representing its potential work, were not adequately recorded.

In January, 1893, I resumed these observations at Washington with apparatus with which I sought to remedy these defects, using as a station the roof of the north tower of the Smithsonian Institution building, the top of the parapet being 142 feet (43·3 meters) above the ground, and the anemometers, which were located above the parapet, being 153 feet (46·7 meters) above the ground. I placed them in charge of Mr. George E. Curtis, with instructions to take observations under the conditions of light, moderate, and high winds. The apparatus used was, first, a Weather Bureau Robinson anemometer of standard size, with aluminum cups. Diameter to center of cups, 34 cm.; diameter of cups, 10·16 cm.; weight of arms and cups, 241 grammes; approximate moment of inertia, 40,710 gr. cm.$^2$

A second instrument was a very light anemometer, having paper cups, of standard pattern and diameter, the weight of arms and cups being only 74 grammes, and its moment of inertia 8,604 gr. cm.$^2$

With this instrument a number of observations were taken, when it was lost by being blown away in a gale. It was succeeded in its use by one of my own construction, which was considerably lighter. This was also blown away. I afterward employed one of the same size as the standard pattern, weighing 48 grammes, having a moment of inertia of 11,940 gr. cm.$^2$, and finally, I constructed one of one-half the diameter of the standard pattern, employing cones instead of hemispheres, weighing 5 grammes, and having a moment of inertia of but 300 gr. cm$^2$.

In the especially light instruments, the electric record was made at every half revolution, on an ordinary astronomical chronograph, placed upon the floor of the tower, connected with the anemometer by an electric circuit. Observations were made on January 14, 1893, during a light wind having a velocity of from 9 to 17 miles an hour; on January 25 and 26, during a moderate wind, having a velocity of from 16 to 28 miles an hour; and on February 4 and 7, during a moderate and high wind ranging from 14 to 36 miles an hour. Portions of these observations are given on Figs. 2, 3 and 4. A short portion of the record obtained with the standard Weather Bureau anemometer during a high northwest wind is given on Fig. 5.

A prominent feature presented by these diagrams is that the higher the absolute velocity of the wind, the greater the relative fluctuations which occur in it. In a high wind the air moves in a tumultuous mass, the velocity being at one moment perhaps 40 miles an hour, then diminishing to an almost instantaneous calm, and then resuming.*

The fact that an absolute local calm can momentarily occur during the prevalence of a high wind was vividly impressed upon me during the observations of February 4, when chancing to look up to the light anemometer, which was revolving so rapidly that the cups were not separately distinguishable, I saw them completely stop for an instant, and then resume their previous high speed of rotation, the whole within the fraction of a second. This confirmed the suspicion that the chronographic record even of a specially light anemometer at most but imperfectly notes the sharpness of these internal changes. Since the measured interval between two electric contacts is the datum for computing the velocity, an instantaneous stoppage, such as I accidentally saw, will appear on the record simply as a slowing of the wind, and such very significant facts as that just noted will be necessarily slurred over, even by the most sensitive apparatus of this kind.

However, the more frequent the contacts, the more nearly an exact record of the fluctuations may be measured, and I have, as I have stated, provided that they should be made at every half revolution of the anemometer, that is, as a rule, several times a second.†

I now invite the reader's attention to the actual records of rapid changes that take place in the wind's velocity, selecting as an illustration the first 5½ minutes of the diagram plotted on Fig. 3.

The heavy line through points, A, B and C, represents the ordinary record of the wind's velocity, as obtained from a standard Weather Bureau anemometer during the observations recording the passage of two miles of wind. The velocity, which was at the beginning of the interval considered nearly 23 miles an hour, fell during the course of the first mile to a little over 20 miles an hour. This is the ordinary anemometric record of the wind at such elevations as this (47 meters) above the earth's surface, where it is free from the immediate vicinity of disturbing irregularities, and where it is popularly supposed to move with occasional variation in direction, as the weathercock indeed indicates, but with such nearly uniform movement that its rate of advance is, during any such brief time as two or three minutes, under ordinary circumstances, approximately uniform. This then may be called the "wind," that is, the conventional "wind" of treatises upon aerodynamics, where its aspect as a practically continuous flow is alone considered. When, however, we turn to the record made with the specially light anemometer, at every second, of this same wind, we find an entirely different state of things. The wind starting with the velocity of 23 miles an hour, at 12 hours, 10 minutes, 18 seconds, rose within 10 seconds to a velocity of 33 miles an hour, and within 10 seconds more fell to its initial speed. It then arose within 30 seconds to a velocity of 36 miles an hour, and so on, with alternate risings and fallings, at one time actually stopping; and, as the reader may easily observe, passing through 18 notable maxima and as many notable minima, the average interval from a maximum to minimum being a little over 10 seconds, and the average change of velocity in this time being about 10 miles an hour. In the lower left hand corner of Fig. 3 is given a conventional representation of these fluctuations in which this average period and amplitude is used as a type. The above are facts, the counterpart of which may be noted by any one adopting the means the writer has employed. It is hardly necessary to observe that almost innumerable minor maxima and minima presented themselves, which the drawing cannot depict.

In order to insure clearness of perception, the reader will bear in mind the diagram does not represent the velocities which obtained coincidently, along the length of two miles of wind represented, nor the changes in velocity experienced by a single moving particle during the interval, but that it is a picture of the velocities which were in this wind at the successive instants of its passing the fixed anemometer, which velocities, indeed, were probably nearly the same for a few seconds before and after registry, but which incessantly passed into—and were replaced by—others, in a continuous flow of change. But although the observations do not show the actual changes of velocity which any given particle experiences in any assigned interval, these fluctuations cannot be materially different in character from those which are observed at a fixed point, and are shown in the diagram. It may perhaps still further aid us in fixing our ideas to consider two material particles as starting at the same time over this two mile course; the one moving with the uniform velocity of 22·6 miles an hour (33 feet per second), which is the average velocity of the wind as observed for the interval between 12 hours, 10 minutes, 18 seconds and 12 hours, 15 minutes, 45 seconds on February 4; the other during the same interval, having the continuously changing velocities actually indicated by the light anemometer as shown on Fig. 3. Their positions at any time may, if desired, be conveniently represented in a diagram where the abscissa of any point represents the elapsed time in seconds, and the ordinates show the distance in feet, of the material particle from the starting point. The path of the first particle will thus be represented by a straight line, while the path of the second particle will be an irregularly curved line, at one time above, and at another time below the mean straight line just described, but terminating in coincidence with it at the end of the interval. If now all the particles in two miles of wind were simultaneously accelerated and retarded in the same way as this second particle, that is, if the wind were an inelastic fluid, and moved like a solid cylinder, the velocities recorded by the anemometer would be identical with those that obtained along the whole region specified. But the actual circumstance must evidently be far different from this, since the air is an elastic and nearly perfect fluid, subject to condensation and rarefaction. Hence the successive velocities of any given particle (which are in reality the resultant of incessant changes in all directions) must be conceived as evanescent, taking on something like the sequence recorded by these curves, a very brief time before this air reached the anemometer, and losing it as soon after.

It has not been my purpose in this paper to enter upon any inquiry as to the cause of this non-homogeneity of the wind. The irregularities of the surface topography (including buildings, and every other surface obstruction) are commonly adduced as a sufficient explanation of the chief irregularities of the surface wind; yet I believe that at a considerable distance above the earth's surface (*e. g.* one mile) the wind may not even be approximately homogeneous, nor have an even flow; for while, if we consider air as an absolutely elastic and frictionless fluid, any motion impressed upon it would be preserved forever, and the actual irregularities of the wind would be the results of changes made at any past time, however remote; so long as we admit that the wind, without being absolutely elastic and frictionless, is nearly so, it seems to me that we may consider that the incessant alternations which it here appears make the "wind" are due to past impulses and changes which are preserved in it, and which die away with very considerable slowness. If this be the case, it is less difficult to see how even in the upper air, and at every altitude, we might expect to find local variations or pulsations, not unlike those which we certainly observe at minor altitudes above the ground.*

*(To be continued.)*

## THE TEMPERATURE OF IGNITION OF EXPLOSIVE GASEOUS MIXTURES.

By A. E. Tutton.

An important contribution to our knowledge of this subject is communicated to the *Berichte* by Prof. Victor Meyer, of Heidelberg, in conjunction with his assistant, Herr A. Munch. The interesting experiments which were carried out some eighteen months ago in the Heidelberg laboratory, concerning the conditions under which the explosion or silent combination of gaseous mixtures occurs, left the question of the precise temperatures of explosive combination undetermined, inasmuch as the necessary high temperatures were attained by the use of boiling salts whose temperatures of ebullition lay a considerable number of degrees apart. The researches have since been continued under conditions in which it has been found possible to determine the actual temperatures with precision. In these experiments any possibility of the occurrence of appreciable amounts of silent combination has been avoided, in order that the determinations of the temperature of explosive combination might be unaffected by errors due to that cause. The conspicuous novelty of the method adopted consists in placing the small bulb containing the mixture to be exploded inside the larger bulb of the air thermometer employed to determine the temperature, thus at once insuring that the explosion bulb and the thermometer bulb shall be heated to precisely the same temperature. The objection which at first suggests itself, that the heat suddenly developed at the moment of explosion might exert a disturbing influence upon the indications of the air thermometer, was proved by direct and repeated experiment to be without validity, such disturbance being found to be too small to be measured. The bulb in which the explosion is brought about is not closed, for the explosion of such detonating mixture of gases at rest, that is to say, confined to a closed space, is so violent that if the glass escapes

* It will be noticed that the fact of observation here is not so much the movement of currents, such as the writer has since learned was suggested by Lord Rayleigh so long ago as 1883, still less of the movement of distinct currents at a considerable distance above the earth's surface, but of what must be rather called the effect of the irregularities and pulsations of any ordinary wind, within the immediate field of examination, however narrow.

See the instructive article by Lord Rayleigh in *Nature*, April 5, 1883. Lord Rayleigh remarks that continued soaring implies "(1) that the course is not horizontal, (2) that the wind is not horizontal, or (3) that the wind is not uniform." "It is probable," he says, "that the truth is usually represented by (1) or (2); but the question I wish to raise is whether the cause suggested by (3) may not sometimes come into operation."

* An example of a very rapid change may be seen on Fig. 4, at 12:23 P. M.

† Here we may note the error of the common assumption that the ordinary anemometer, however heavy, will, if frictionless, correctly measure the velocity of the wind, for the existence of "vis inertiæ," it is now seen, is not indifferent, but plays a most important part where the velocity suffers such great and frequent changes as we here see it does, and where the rate at which this inertia is overcome, and this velocity changed, is plainly a function of the density of the fluid, which density we also see reason to suppose itself varies incessantly, and with great rapidity. Though it is probable that no form of barometer in use does justice to the degree of change of this density, owing to this rapidity, we cannot, nevertheless, suppose it to exceed certain limits, and we may treat the present records, made with an anemometer of such exceptional lightness, as being comparatively unaffected by these changes in density, though they exist.

* In this connection, reference may be made to the notable investigations of Helmholtz, on Atmospheric Movements, *Sitzungsberichte*, Berlin, 1888–1889.

pulverization it is much distorted, owing to the temperature to which it requires to be heated being about its softening point. The distortion usually takes the form of a shrinking from two opposite points, where the glass is drawn in and distended to such an extent as to produce two internal spheres. Such deformation would of course alter considerably the volume of the air thermometer. This is avoided by attaching a long stem to the bulb, open at the free extremity, and of passing a slow current of the gaseous mixture through the apparatus. The bulb of the thermometer was heated by means of a bath of a fused alloy consisting of equal parts of tin and lead, and it was found immaterial whether the thermometer was directly immersed in the molten metal or protected by means of a closely fitting refractory metal sheath. The estimation of the temperature was effected by displacing the air of the thermometer, whose volume was known, by means of a current of hydrochloric acid gas, and measuring its volume over distilled water which had recently been freed from air by boiling.

The first series of experiments were made with the detonating electrolytic mixture of hydrogen and oxygen. The gases were freed from ozone by passage through a solution of potassium iodide. They were then washed through water, with which a Woulfe's bottle was almost filled, after which they traversed a tube packed with numerous disks of brass gauze, which were found effectual in preventing the explosion from traveling back to the Woulfe's bottle. The mixed gases were then allowed to enter the explosion bulb by means of a capillary tube passing down the stem to the bottom of the bulb. The rapidity of the gaseous stream was found to exert no influence upon the temperature of explosion, within the limits imposed by the mode of experimenting. The bath was then gradually raised to the neighborhood of the combining temperature, and the instant the explosion ensued the air contained in the thermometer was displaced by hydrogen chloride, collected over water in the measuring vessel, and its volume ascertained on the attainment of atmospheric temperature and pressure. By displacing the air the instant the detonation was heard, any appreciable augmentation of the temperature during the moment of explosion was prevented.

As the result of several series of experiments carried out with four distinct sets of apparatus, the temperature of explosion of electrolytic hydrogen and oxygen is found to vary from 612° to 686°. It would thus appear, conformable with the supposition of Prof. Van t'Hoff from theoretical considerations, that this mixture is incapable of exhibiting a sharply fixed temperature of explosion. Moreover, it makes no difference whether the mixture is dry or moist; for if dried a small amount of silent combination invariably renders it again moist before explosion occurs.

It has been currently supposed that the presence of sharp solid fragments, such as those of glass, exerts a lowering effect upon the temperature of explosion of hydrogen and oxygen. This supposition has been practically tested and found wanting in accuracy. Neither glass fragments nor sea sand was found to reduce the temperature below the limits above stated. A remarkable result, however, was obtained when pieces of platinum foil and wire were introduced into the explosion bulb. It was found impossible in their presence to bring about an explosion, even when the temperature of the bath was raised to 715°. Quiet combination invariably ensued.

The size of the explosion vessel appears to be immaterial, except when reduced to very small dimensions, such as 4·5 mm. diameter, as in the case of the smallest bulb tested, when the range of molecular forces is approached. In six experiments with this small bulb no explosion occurred; in others the explosion did not occur in the vessel, but the quiet combustion there initiated was transmitted along the leading tube, through the tube containing the brass gauze disks, and eventually occasioned an explosion in the wash bottle, disastrous to the latter.

In the cases of other explosive mixtures the admixture was effected, in the proper proportion, in a three liter flask, from which the gases were driven first through a wash bottle, and subsequently through a test tube, arranged likewise as a small safety wash bottle, to prevent the explosion reaching the larger one.

Carbon monoxide and oxygen, in the proportion to form carbon dioxide, were found to suffer, for the most part, silent combination in the apparatus, and the wide limits of the observed temperatures of explosion, 636° to 814°, in those cases when explosion did ensue, were found to be due to more or less of such silent combination.

Gaseous mixtures of hydrocarbons and oxygen were found, however, with the exception perhaps of marsh gas and oxygen, to exhibit practically no quiet combination; and these mixtures have afforded most trustworthy and constant temperatures of explosion.

Marsh gas was found to explode, as a rule, with oxygen at temperatures varying from 656° to 678°, but occasionally quiet and complete combustion occurred. Other hydrocarbons never failed to yield an explosion.

Ethane detonated with oxygen in three experiments at 622°, 605°, and 622° respectively. A mixture of ethylene and oxygen exploded at 577°, 590°, and 577° in three consecutive experiments. Acetylene prepared by Gattermann's method, which in Prof. Meyer's experience yields it in a purer state than the more recent convenient method discovered by Maquenne, explodes with oxygen with exceptional violence, the wash bottle being destroyed in every experiment. The temperature of this explosion was very constant, 510°, 515°, and 509° being successively observed. Propane mixed with five times its volume of oxygen likewise exhibits a very constant temperature of ignition, 548°, 545°, and 548° being indicated in three determinations. Propylene exploded with four and a half times its volume of oxygen at 497°, 511°, and 499°. Isobutane mixed with six and a half times its volume of oxygen detonated at 549°, 550°, and 545°; and isobutylene at 546°, 548°, and 537°. Finally, coal gas mixed with thrice its volume of oxygen was found to explode in three experiments at the remarkably constant temperatures of 649°, 647°, and 647°. It was found impossible, however, to induce a mixture of coal gas and air to explode under these experimental conditions.

It will be clearly seen from the above experiments with gaseous mixtures of hydrocarbon and oxygen that the temperature of explosion falls as the content of carbon increases. Thus the mean temperatures for methane, ethane and propane are 667°, 616°, and 547° respectively. Further, the temperature also falls with the degree of saturation, or in other words, the less saturated the hydrocarbons become, the more readily do they ignite in contact with oxygen. Thus ethane, ethylene and acetylene explode with oxygen at 616°, 580° and 511°; propane and propylene at 547° and 504; and isobutane and isobutylene at 548° and 543°. It will also be observed, however, as would be expected, that these differences due to difference of saturation diminish as the series are ascended.—*Nature.*

[Continued from SUPPLEMENT, No. 945, page 15105.]

## ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

*Lecture IV.*†

THE object of this lecture is to afford a guide to the metal work in the art collections in the South Kensington Museum, which are singularly rich in examples of special interest from a metallurgical point of view, and it is in this aspect alone that I can claim any authority in considering them.

The subject with which I have to deal is the "materials used for art metal work," but as they are treated from the point of view of the collections at South Kensington, it will be well to state some historical facts which might otherwise be omitted.

The range of metals and alloys at the disposal of the craftsman is really very wide, but he nevertheless restricts his efforts within narrow limits, and employs but few materials. The pure metals are seldom used, and have hardly any applications in art industries except when in union with other metals. A notable exception is, however, presented by wrought iron work, which I do not propose to deal with, as it has already been admirably treated by Mr. Starkie Gardner. It may be sufficient to point out that the purer the iron is, the better suited it will be for hammering and twisting into delicate shapes, while the presence of some $\frac{2}{10}$ per cent. of carbon, which does not impair its ductility, sensibly increases its durability and rigidity. Even gold is almost always employed with more or less alloying metal added to it, and the alloys of gold have, as I shall subsequently show, a very wide range of tint. Silver, also, is seldom used unalloyed.

The two series of alloys which have prominence in the history of art metal work are those of copper and tin, the bronzes, and the copper-zinc series, the brasses. Next in importance would come the lead-tin alloys, the petwers. Of the alloys of the precious metals, the gold-copper, the gold-silver, and the silver-copper are the most important.

A very beautiful modern chalice, destined for use in the church of St. Martin, Wonersh, was shown as a good example of art work in pewter.

It may be well to take the bronzes first, and the important question at once suggests itself, Was copper employed before the general adoption of the alloy of copper and tin in industrial art? It is well known that the word copper is derived from Cyprus, famed for its copper, the island being under the special patronage of Venus, to whom copper was ultimately, though not, I think, at first, dedicated.

Berthelot has given us the analysis‡ of a little Chaldean statuette of a god, now in the Louvre, which is considered to date from 4000 B. C., and it proved to be of metallic copper. There is also an analysis by Berthelot§ of the scepter of the King Pepi I., a king of the sixth Egyptian dynasty. This scepter, a cylinder 12 centimeters long, covered with hieroglyphics, is in our own British Museum, and its date is believed to be some 3500 to 4000 years B. C. It is of pure copper, probably derived from the mines in Mount Sinai, which are known to have been worked by the Egyptians in the third dynasty.

From the standpoint of anthropology, however, copper plays an essentially different part in prehistoric culture now from what was assigned to it but a short time ago. Whereas it had been assumed that in Europe copper periods existed only in certain localities, Hungary, Ireland, and Spain finds of copper have recently increased to such an extraordinary extent that the assumption of a special copper age, which was in point of time prior to the bronze age, and contemporary with the later stone age, seems to archæologists now inevitable.‖

I cannot enter here into the discussion of the first appearance of bronze. I was inclined to accept the evidence which attributes the name bronze to Brundusium, for it seems clear that just as Cyprus was celebrated for its copper, Brundusium was famous for its manufacture of bronze, especially of mirrors, but my friend Sir George Birdwood sends me the following statement bearing upon the question:

"I cannot find any connection between bronze and Brundusium. This first came into notice only in the third century B. C., and apparently long before the Italian word, *bronzo*, was formed, all memory of any trade in bronze through Brundusium had been lost. The word appears in its English form first in the sixteenth century, and evidently from the Italian; and the Italian *bronzo* is said to mean, originally, 'live coal'—and in reference to their alloy, points to its mode of preparation by burning. Brunette is the same word, and brown and burnt. The objects about us are many, our words for them very few!"

But with regard to the period of its introduction for industrial use, whatever may be the date of Schliemann's "first prehistoric city," Ilios, many of the objects found in it were certainly of nearly pure copper. Dr. Schliemann asked me to analyze two nails or pins which were exhibited, with the rest of his collection, at South Kensington. These contained respectively:*

I.

| | |
|---|---|
| Copper | 97·83 |
| Tin | 0·21 |
| Iron | 0·90 |
| Nickel and cobalt | traces. |
| | 98·94 |

II.

| | |
|---|---|
| Copper | 98·20 |
| Iron | 0·75 |
| Sulphur | 0·13 |
| Tin | trace. |
| | 99·08 |

The metal examined was from the center of the pins, and was freed as nearly as might be from the investing layer of carbonates and oxides.

I believe that the presence of tin is entirely accidental. Schliemann concluded, on the evidence supplied by these analyses, that all the objects from the first and second cities of Hissarlik were of copper, and indicated the existence of a pre-bronze age, and even if the date of these copper articles be no older than 1500 B. C., their occurrence is very useful in enabling the period at which tin was alloyed with copper to be defined, even roughly, for in the layer of deposits which Schliemann calls the third city, and identifies with Homer's Troy (about 1200 B. C), the articles I analyzed were undoubtedly of bronze. M. Damour, of Lyons, also analyzed some of the battle axes from this third city and found them to contain:

I.

| | |
|---|---|
| Copper | 95·80 |
| Tin | 3·84 |
| | 99·64 |

II.

| | |
|---|---|
| Copper | 90·67 |
| Tin | 8·64 |
| | 99·31 |

I found in other portions of the same axes:

III.

| | |
|---|---|
| Copper | 93·80 |
| Tin | 5·70 |
| | 99·50 |

IV.

| | |
|---|---|
| Copper | 95·41 |
| Tin | 4·39 |
| | 99·80 |

Sir George Birdwood tells me that for a thousand years before 1200 B. C. the Phœnicians had been actively trading in the Levant, and their commerce was at its height 1500 B. C.

Our knowledge as to the first appearance of bronze has, however, received recently a somewhat astonishing piece of evidence. Dr. Flinders Petrie has found a rod of metal, which is believed—from the position in which it was found at Meydum—to date from the IVth Dynasty, about B. C. 3700. This rod was analyzed by Dr. Gladstone,† who finds that it contains:

| | |
|---|---|
| Copper | 89·8 |
| Tin | 9·1 |
| Arsenic | 0·5 |
| Antimony, Iron, Sulphur | traces. |
| | 99·4 |

So that we have here a specimen of bronze of 3700 B. C. which has about the ratio of nine copper to one tin, characteristic of far later and even of modern bronzes.

Further evidence as to the composition of ancient bronze is, however, forthcoming. At the request of Sir John Donnelly, Secretary of the Science and Art Department, analyses were recently made,‡ under my direction, of certain objects in our own South Kensington collections, and a few antique bronzes in the British Museum. These analyses were made by Mr. A. Wingham, a chemist of great skill, and are absolutely trustworthy. Of the objects selected, probably the oldest is No. 82, and the next is No. 79. It is important to remember that the Etruscans were not dependent for tin solely on imports.

*No.* 79.—*Bronze Figure of a Lion.* Etruscan work. Fifth century B.C. '73. 8-20. 251.

*Analysis.*

| | |
|---|---|
| Copper | 82·10 |
| Tin | 12·64 |
| Lead | 1·86 |
| Zinc | 0·73 |
| Iron | trace. |
| | 97·33 |

*No.* 82.—*Fragment of Drapery* found with leg of bronze statue. Greek sculpture. About B. C. 450. '86. 3-24. 7*a*.

*Analysis.*

| | |
|---|---|
| Copper | 84·49 |
| Tin | 9·47 |
| Lead | 5·31 |
| Iron | trace. |
| | 99·27 |

There is, therefore, a clear case for the introduction of tin in Etruscan and Greek work in the fifth century before Christ. The presence of zinc is probably accidental.

But now we must consider the important point con-

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† Some of the particulars contained in this lecture were given in a lecture delivered at South Kensington Museum in 1892, and some portions, relating to Japanese art metal work, formed the subject of a paper read before the Applied Art Section of this Society, which appeared in the *Journal* June 30, 1890.

‡ "Ann. de Chim. et de Phys.," xii., 1887, p. 131.

§ "Ann. Chim. et de Phys.," xvii., 1889, p. 507.

‖ "Prehistoric Antiquities of the Aryan Peoples," Schrader and Jevons edition, p. 191.

* Ilios, 1880, p. 251.

† "Proc. Soc. Biblical Archæology," March, 1892.

‡ The numbers given over each analysis refer to the "Report on the Analyses of various examples of Oriental Art Metal Work in the South Kensington Museum, and other Collections," made under the direction of the author of this lecture by Mr. Arthur Wingham, 1892. Price 6d. It may be purchased at the South Kensington Museum.

nected with the occurrence of lead and zinc. An eminent and careful authority, Dr. C. Drury Fortnum,* leans to the view that the presence of lead in bronze, indicated by Pliny, was due to the addition of the metal as an adulterant of the tin, and with a view to increase the fusibility of the alloy. No doubt tin was adulterated with lead; in fact, Pliny tells us that it was so; but my own opinion is that the fact that the presence of lead enables the bronze both to be more easily fused and, above all, to assume a beautiful velvety brown patina, was recognized far earlier than has been supposed, and this supposition is sustained by the occurrence of lead in analysis No. 82 of the fragment of the Greek bronze, the date of which is about B. C. 450.

With regard to the presence of lead in large bronze works, the Florentine artists do not seem to have been very particular as to its amount. For instance, the description of the casting of the Perseus in the Loggia di Lanza at Florence is too well known to need repetition, and I will only refer to it to point out that, if Cellini's boastful account of the casting is true, there must be far more lead in it than the artist intended, for he says that, finding the metal was setting in the furnace before he had time to transfer it to the mould, he ordered all his pewter dishes and porringers, which were in number about 200, to be placed before the ducts through which the bronze had to run, and presently the bronze became fluid again, and the casting successfully accomplished.

Now, with regard to the presence of zinc, Pliny describes in much detail the various shades of color presented by bronze, and it is of interest to fix the date, or at least the period, at which zinc was deliberately introduced, in view of the very important part played by zinc either as affecting the natural tint of the tin-copper alloys or as influencing the color of the patina produced by atmospheric action. In order to effect the introduction of zinc into bronze, it was only necessary to add zinc ores to the furnace charge; the metallic zinc became reduced from the ore and passed into the alloy. I have elsewhere expressed the view that brass, which was common enough in Roman time, was not much used in this country until my namesake, William Austen, in 1460, made the magnificent monument in brass which covers the greatness of Richard Beauchamp, Earl of Warwick.

*No. 9.—Astrolabe?* Brass engraved. It appears to have been gilt, and is slightly inlaid with silver. It bears the date of the Hegira 598 (A. D. 1202), and was made at Damascus by Abdul Rahman, son of Iusuf. *Persian* or *Saracenic.* 9¾ in. by 8 in. 504. '88.

*Analysis.*

| | |
|---|---|
| Copper | 79·40 |
| Arsenic | 0·157 |
| Antimony | nil. |
| Tin | 1·125 |
| Lead | 2·145 |
| Bismuth | trace. |
| Iron | 0·350 |
| Nickel | trace. |
| Zinc, by diff | 16 823 |
| Silver | trace. |
| Gold | nil. |
| | 100·000 |

*No. 4.—Candlestick.* Brass, inlaid with silver, and engraved with Arabic inscriptions recording Memluk titles of the 14th century round base and neck and on other parts, divided by medallions of geometrical designs and by rosettes of flowers. *Saracenic.* 14th century. H. 10 in., diam. 9 in. 4505. '58.

*Analysis.*

| | |
|---|---|
| Copper | 84·75 |
| Arsenic | trace. |
| Antimony | nil. |
| Tin | 2·360 |
| Lead | 0·656 |
| Bismuth | trace. |
| Iron | 0·098 |
| Nickel | trace. |
| Zinc, by diff | 12·084 |
| Silver | 0·052 |
| Gold | nil. |
| | 100·000 |

*No. 7.—Mortar.* Brass, octagonal, chased with arabesques and Kufic inscriptions. Round the sides are projecting knobs, and on one side is a ring suspended from a bull's head. Found in the ruins of the city of Rhages. *Persian.* 10th or 11th century. H. 5¼ in., diam. 7 in. 466. '67.

*Analysis.*

| | |
|---|---|
| Copper | 68·19 |
| Arsenic | trace. |
| Antimony | nil. |
| Tin | 3·327 |
| Lead | 14·990 |
| Bismuth | trace. |
| Iron | 0 448 |
| Nickel | trace. |
| Zinc, by diff | 12·963 |
| Silver | 0·082 |
| Gold | nil. |
| | 100·000 |

*No. 40.—Vase,* with handle and cover. *Phuldan.* Perforated brass; the cover surmounted by a knob; the handle formed by two dragons. *Nepal.* H. 11½ in., diam. 7½ in. 89. (I.S.) 1886.

*Analysis.*

| | |
|---|---|
| Copper | 78·58 |
| Arsenic | trace. |
| Antimony | 2·037 |
| Tin | 0 236 |
| Lead | 2·721 |
| Bismuth | 0·070 |
| Iron | 0·140 |
| Nickel and cobalt | 0·068 |
| Zinc | 15·849 |
| | 99·701 |

* "A descriptive catalogue of the bronzes in the South Kensington Museum, 1876. Introduction."

*No. 53.—Gun.* Analyses of two samples, the first from the mouth end, the other from the tail or breech end. Lent by H.R.H. Prince of Wales. Length, 9 ft. 3 in.; bore, 3¾ in.

| | |
|---|---|
| Copper | 89·49 |
| Arsenic | trace. |
| Antimony | trace. |
| Tin | 4·893 |
| Lead | 2·118 |
| Bismuth | trace. |
| Iron | 0·238 |
| Nickel | trace. |
| Zinc | 3·049 |
| Gold | nil. |
| Silver | nil. |
| | 99·788 |
| Copper | 85·93 |
| Arsenic | trace. |
| Antimony | trace. |
| Tin | 7·654 |
| Lead | 4·748 |
| Bismuth | trace. |
| Iron | 0·210 |
| Nickel | trace. |
| Zinc | 1·501 |
| Gold | nil. |
| Silver | nil. |
| | 100·043 |

*No. 51.—Bell,* with dragons in relief, and incised inscription. Burma. 05,219.

*Analysis.*

| | |
|---|---|
| Copper | 78·12 |
| Arsenic | 0·221 |
| Antimony | nil. |
| Tin | 19·18 |
| Lead | 1·913 |
| Bismuth | 0·097 |
| Iron | 0·105 |
| Nickel | 0·114 |
| Zinc | nil. |
| Silver | 0·090 |
| Gold | nil. |
| | 99·840 |

The bell contained on its outer surface a long inscription, of which the following is part (translation):

"We two, brother and sister, have given this bell as an offering to the seven Precious Things. In this attempt to merit Neh'ban, our arrangement was as follows: We took our own weight in gold, and in silver and bright copper and other metal (Laukad, the Pali word used, implies five metals—gold, silver, copper, iron, lead), and mixed them well together. In the year 1209 (1847 A. D.), in the hot season, at a fortunate hour, I had moulded it, setting my heart on giving it in alms.

"As I wrote the inscription I offered up abundant prayer that no enemies or troubles might come nigh me, and that I might attain Neh'ban.

"Then I dedicated it."

The next analyses are similar to the above.

*No. 52.—Bell,* bronze. Swinging shackle ornamented with two grotesque lions. With inscription, dated 1828 A. D. *Burmese.* H. 3 ft. 4 in., diam. 2 ft. 2 in. Presented by Commander C. McLaughlin, R.N. 76. (I.S.) 1884.

*Analyses of Two Samples, the first taken from the Lip, the other from the Top.*

| | |
|---|---|
| Copper | 78·50 |
| Arsenic | 0·205 |
| Antimony | 0·198 |
| Tin | 12·73 |
| Lead | 5·520 |
| Bismuth | 0·215 |
| Iron | 0·322 |
| Nickel | trace. |
| Zinc | 1·749 |
| Silver | 0·263 |
| Gold | nil. |
| | 90·702 |
| Copper | 78·05 |
| Arsenic | 0·154 |
| Antimony | 0·229 |
| Tin | 12·85 |
| Lead | 6·292 |
| Bismuth | 0·251 |
| Iron | 0·210 |
| Nickel | trace. |
| Zinc | 1·524 |
| Silver | 2·18 |
| Gold | nil. |
| | 99·778 |

*No. 60.—Bronze Tortoise, Modern Japanese.*

*Analysis.*

| | |
|---|---|
| Copper | 81·62 |
| Tin | 4·61 |
| Lead | 10·21 |
| Iron | 0·22 |
| Zinc | 2·42 |
| | 99·08 |

This sample, from a specimen in my own collection, was a very good and well defined casting, moderately hard and brittle.

Of all the bronze castings I have seen, two stand out in memory as being specially impressive, one of these is 17th century Italian work, and the other modern Japanese. The former of these is the large statue in the magnificent Medici chapel of the Church of St. Lorenzo, Florence, of Ferdinand III. (1609), modeled by Gian da Bologna, and cast by Pietro Tacca. Bologna's character must have presented a marked contrast to that of Cellini, for contemporary accounts represent him as being "honest, disinterested, industrious, obliging, and agreeable to all."* The statue is composed of different colored bronzes, probably lightly gilt in parts, and the texture of the brocaded robes is wonderfully rendered, as in the fur cape. The statue in a second niche of Cosimo IV. (1620) was entirely by Pietro Tacca. The tints of the bronze are quite fresh, and can hardly have been impaired by age.

*(To be continued.)*

* "Florence," by C. Yriarte. Paris, 1881.


THE

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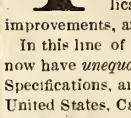

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## THE MANUFACTURE OF FIREWORKS IN FRANCE.

At all epochs of history, for centuries back, days of public rejoicing have been celebrated with fireworks. The sight of colored fires burning in the air and of pieces of fireworks set up on the ground has always served to excite popular enthusiasm.

On the occasion of the visit of the Russian sailors to Paris, this sort of spectacle was not forgotten. Magnificent fireworks were set off at the Trocadero on October 23, 1893. Fireworks of such importance have now become quite rare, and the Ruggieri establishment, which, since the one hundred and fifty or more years that it has been in existence, has undertaken the manufacture of the largest fireworks, regards these as one of the most important that have been seen in twenty-five years. So it has appeared to us of interest to follow the preparation and installation thereof, and this we are enabled to do through the obligingness of the heads of the house.

When we see those long trains of fire that afterward fall in many-colored stars rush into space, and when we are spectators of the combustion of those huge pieces representing palaces, vessels, and allegorical subjects, we generally have no suspicion of the way in which all this is done. So it is into the side scenes of the pyrotechnist that we wish to introduce the reader.

The establishment under consideration, which occupies an area of no less than 12,000 square meters, is situated on the road from Paris to Saint Denis. It will be understood that, aside from reasons of economy, there is also a question of prudence that carries with it the necessity of keeping remote from centers of habitation when substances as dangerous as those that form the basis of pyrotechny are handled. Special precautions are taken and each workman is isolated in a special shop, consisting of a shed constructed of very light materials, such as slabs of compressed cork and cardboard. Each of these sheds is separated from its neighbors by hurdles filled with earth (Fig. 1). In this way, if a disaster occurs, it is localized. Moreover, we must state that precautions of all kinds are so taken that accidents are becoming rarer and rarer.

The substances most employed in the manufacture of fireworks are, in the first place, saltpeter, sulphur, and charcoal, which, mixed in proportions that are not the same as ordinary powder, serve for the manufacture of rockets and fire sheaves. Chlorate of potash, the combustive *par excellence*, which, united with the salts of baryta, strontia, copper, etc., gives all the colors that were unknown to ancient pyrotechny, since the discovery of chlorate of potash by Berthollet dates only from the end of the last century. Gunpowder is also much employed by pyrotechnists for the firing of bombs and the manufacture of detonating pieces. They are obliged to purchase it from the government manufactories. The Ruggieri establishment consumes more than ten thousand kilogrammes of it a year.

We have no intention of entering into the details of the manufacture of each piece of fireworks. That would require a volume, and such a volume, very complete and very well written, already exists. To it we refer those of our readers who would like to have more details. As for us, we simply wish to give here a general idea of the principal pieces employed and of the preparations that the installation of large fireworks necessitate.

As sky rockets, sheaves of brilliant fire, bombs, and port fire constitute the basis of almost all fireworks, we shall pass the method of manufacturing them briefly in review.

The cardboard case designed to contain the composition of a rocket is most generally made of two or three sheets of paper of very good quality procured at a low price from dealers in old paper derived from commercial and other registers.

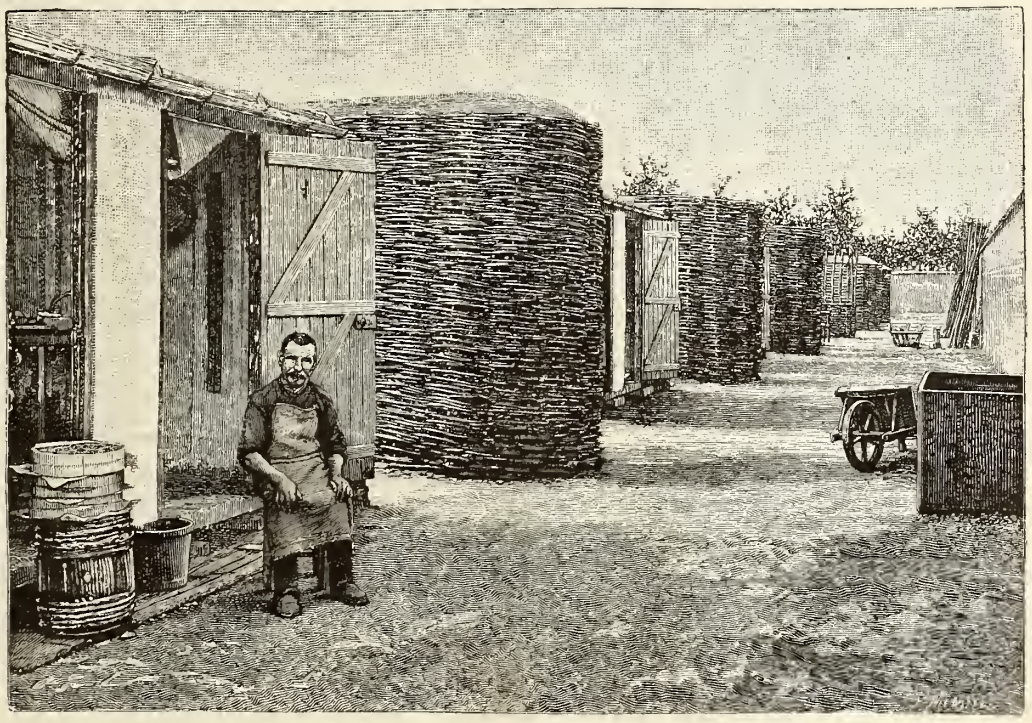


Fig. 1.—ISOLATED SHEDS FOR THE MANUFACTURE OF FIREWORKS.

The cases thus manufactured are mounted upon cylindrical copper rods of the proper diameter and length. The extremity of the case is afterward choked either by means of a card or a special tool. The object of such choking is to present an obstacle to the exit of the gases produced by the combustion and thus to prolong their effect. In the Ruggieri establishment mechanical means are now employed as far as it is possible, and we shall revert to these further along when we come to the subject of charging the rockets. The cases especially are made of new paper on spools that a machine rolls into tubes of the dimensions required to form the rocket. The choking is replaced by a neck of refractory clay that assures a more regular flow of the gases. The cases thus obtained are lighter than the old ones and, consequently, less dangerous when they fall.

The sky rocket, which is also used for signals at sea and in war, is formed of one of these cases, in which the charge is arranged in such a way as to leave an empty space in the interior, called the bore of the rocket, and which occupies a large portion of the length. It suffices for this to arrange in the interior of the case a spindle, which is removed after the charging. This arrangement of the charge permits the composition to ignite over a wide surface at once, and the gas, escaping through the choked aperture of which we have spoken, produces the ascent. Above the charge, surrounding the bore, the composition is solid for a length of about one and one half times the diameter of the tube. In order to guide the rocket during its ascent and keep the choking through which the gas escapes at the lower part, there is adapted to it a long stick of light wood or osier that serves as a rudder, as it were. Although the rocket, as a whole, is not very heavy, yet, since it falls from a great height, it might prove dangerous to children, especially if it should strike them on the head; so it is indispensable to keep the spectators at a considerable distance from the place where it is set off.

The diameter of rockets varies from one centimeter to three and one-half centimeters. Above the mass is arranged in a tube of thin paper the heading, consisting of stars, rain of pearls, etc. It is the solid charge that communicates fire to the heading when the rocket is at the end of its travel. There are certain quite minute precautions to be observed in the arrangement of the solid charge in order that this effect may be produced exactly at the moment desired.

The charging of a rocket requires much care, and

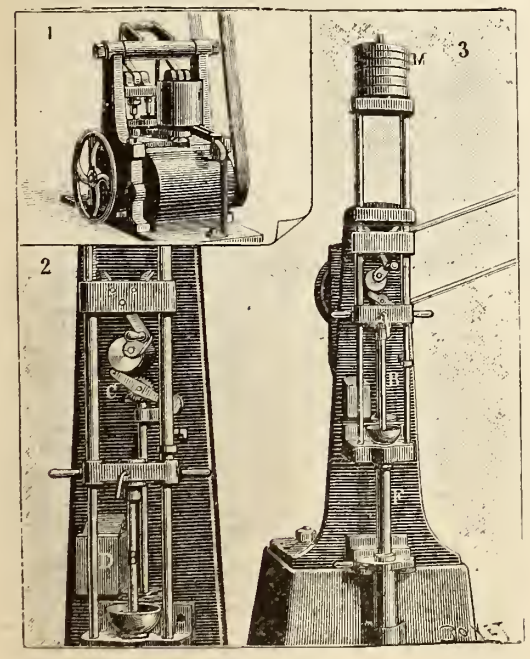



Fig. 2.—No. 1, MACHINE FOR COMPRESSING STARS. Nos. 2 and 3.—MACHINE FOR CHARGING ROCKETS.

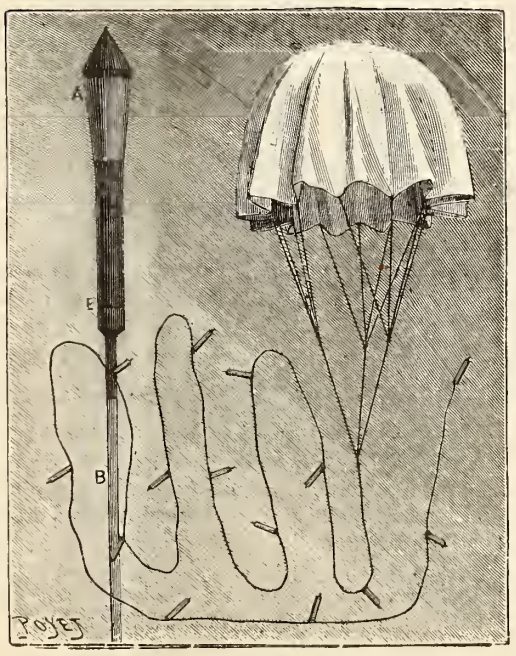



Fig. 3.—PARACHUTE ROCKET.

A, parachute folded; B, stick; E, rocket.

Fig. 4.

MORTAR AND BOMB.

the composition must be well rammed. There are rules that determine the weight of the mass to be employed and the minimum number of blows that it is necessary to give the rod for properly charging.

In the Ruggieri establishment, where a very large number of rockets are manufactured, a machine has been devised that does this work automatically (Fig. 2, Nos. 2 and 3).

The case, F, is secured to a spindle resting upon the foot of the machine. Above, there is a horizontal disk that revolves around a central axis. This is the distributer. It fills the cavities with which it is provided in passing under a receptacle, D, containing the composition, and empties them when it passes over a funnel arranged upon the rocket case. Between each of these charges a copper rod, B, surmounted by a leaden weight, M, effects the compression. A cam, C, allows it to fall a certain number of times, regulated in advance. The machine stops automatically when the charging is finished. A saving in time and manual labor is thus effected, and the work is more regular.

The headings of rockets often consist of many-colored stars. Some of these are manufactured from substances very dangerous to handle. The green stars, especially, composed of nitrate of baryta, sulphur, and chlorate of potash, require delicate manipulation. The other colors are generally less dangerous. The salts of strontia and copper and the sulphide of antimony enter into their composition.

The mixtures that form the stars are compressed under the form of small cylinders of sizes varying according to the dimensions and the height of the rocket's ascent. Here, again, a machine is used for the compression of the composition (Fig. 2, No. 1). As in the preceding machine, we find a distributing disk that takes the composition from a receptacle. It revolves with a jerking motion, and at every stoppage a spindle moved by an eccentric strongly compresses the composition. The disk afterward continuing its travel, the little cylinder thus formed finally reaches an empty space, where it falls into a box arranged to receive it. There is kept on hand a series of these small cylinders, that are all ready to form bouquets of stars of different colors designed for the heading that constitutes the upper part of the rocket.

Another arrangement merits also a few explanations. It consists in placing in a box situated above the solid charge a small parachute made of a thin fabric, and which separates from the rocket and unfolds when the latter has reached the end of its travel (Fig. 3). From this parachute there is suspended by a thread either a crown of stars that hovers over the spectators for quite a long time, or a string of small blue lights forming a sort of luminous *chenille* of a very curious effect.

A slow match, of course, is so arranged as to ignite these preparations only at the moment at which the parachute abandons the balloon. Our engraving gives an idea of the way in which things are arranged when it is desired to obtain *chenilles*. We may see here, too, the external form of a rocket, with its constriction, E (held below by the guiding stick, B), and its cone, A, which contains the parachute and heading.

When it is desired to send a very large number of stars into the air, there is employed a bomb, which is fired from an artillery mortar that, for prudence sake, is buried for three-quarters of its length in the earth.

This bomb consists of two hemispheres of cardboard united by means of numerous strips of paper. It is filled with the chosen packing (in most cases of colored stars), and there is arranged in it the quick match, a small fuse designed to communicate fire to the contents at the moment that the bomb reaches the end of its travel. In order to render it unnecessary to bother every time with the charging of the mortar designed to fire the bomb, there is fixed to the latter, by means of a paper case, the quantity of powder necessary to cause it to ascend. This is what is called the *chasse*. A long slow-match that winds around the bomb and joins the *chasse* protrudes from the mortar after the introduction of the bomb, and serves to ignite the latter (Fig. 4).—*La Nature.*

## ADULTERATED LINSEED OIL.*

THE pernicious system of adulterating oil, carried on by the jobber, and in some cases by the small Western crusher, was, unfortunately, never so prevalent as at the present time. It is this condition of affairs which fosters suspicion and distrust in the minds of certain consumers, who at some period or other have made the mistake of buying a cheap oil, and having found it badly adulterated, declare that to procure a really pure article is one of the most difficult tasks possible. Their objections are frequently based on unjustifiable grounds, as shown by the following incident, which came under the writer's personal observation.

A cask of kettle-boiled oil was shipped to an old consumer, one whose experience would have been considered of sufficient value to warrant the expectation of a correct mode of procedure when testing the quality of an oil. Within a period of a few days the cask of oil was returned, with the statement that it was badly prepared or something worse (here an insinuation was intended to be conveyed that it was adulterated), that it was so inferior in quality that its use was out of the question, and a request to forward an equivalent quantity of genuine oil. Knowing the utter uselessness of entering into a controversy with this man, and that the emphatic statement that the oil was exactly similar to that in stock at the factory, and that all the oil was similarly treated—knowing that these statements would fall on doubting ears, the rejected cask of oil was emptied, its contents placed in other packages, and the same oil was immediately forwarded to the fault finder, and developments were quietly awaited. In two or three days the information was received that the last consignment of oil shipped gave entire satisfaction, there being as much difference between the oil last received and the rejected article as there is between chalk and cheese; coupled with the advice for the future to be more careful and to forward nothing but good oil! Comment on this is needless, but it may be supplemented by stating that the above is not by any means an isolated case.

Boiled oil is frequently adulterated with resin, colophony, cottonseed oil, fish oil, etc. Some oil boilers who purchase the crude oil from the crusher to be treated by themselves, and not infrequently the small crusher, also, place in the boiling kettle one-eighth of the weight of the oil treated of resin oil, ostensibly to increase the hardening properties of the oil, but really to insure a very large profit, altogether out of proportion to the current market value of the commodity. When the turpentine market is sufficiently low, the jobber or middleman (and the writer has recollection of instances where crushers west of Chicago were known to be guilty of similar procedure) will place several barrels of boiled oil along the floor, bung up, and pump from each about one-half gallon of the boiled oil, to be replaced by oil of turpentine, the whole being shipped as a pure boiled oil. The admixture of oil of turpentine with the oil doubtless promotes its drying qualities, but the objection lies in the fact that the article is placed on the market as a pure linseed oil. . . .

By boiling say twenty pounds of oil from a parcel for several hours at the highest safe temperature, being careful at the same time to preserve a uniform temperature, the practical varnish maker can ascertain whether he has properly prepared oil to deal with, whether it will be economical or otherwise; while at the same time its action under manipulation will prove a trustworthy guide when putting the main parcel under treatment afterward. Any peculiarity in the smaller lot—for instance, a tendency to rise or swell in the kettle—would be observed and especially guarded against in the larger lot. The test of a good varnish oil consists, in this case, in its not losing more than 10 per cent. of its original weight in vapors, destructive distillation, etc., and in its retaining a good color, varying from a light color when the operation is begun to a hue gradually deepening and brightening to the peroid of its completion, when the product is changed to a rubber-like substance. So strong is this oil rubber, which is formed by the continuous application of heat at a high temperature (about 550° Fah.), that should a fair sized animal, say a good, strong cat, be unfortunate enough to be placed in the substance when sufficiently cold, it would be utterly unable to extricate itself, notwithstanding the most violent efforts which such an animal can usually exert in such an emergency. The elasticity of this product when drawn out in long strings and its sudden backward spring when released is surprising to the uninitiated. This substance is used in the manufacture of surgical instruments. Some manufacturers of rubber goods make a varnish of the oil alone, boiled to the proper consistency without the aid of nitric acid, while others use gums and various chemicals.

While treating on the subject of oil rubber or caoutchouc, as it is sometimes called, it may be well to observe that no better test for a good quality of oil than the above mentioned method need be applied. Of course, its tediousness and the danger incurred during the operation prohibit its adoption as a regular test for all the purposes for which linseed oil is used, but in the manufacture of linoleum an exception might well be made. After the oil treated has had sufficient time to cool, if it becomes solid without the presence of a sticky or greasy substance, it is undoubtedly pure; but if it should remain sticky and partly fluid, it can be looked upon as an adulterated article.

A convenient form for testing a boiled oil is to cover lightly the surface of a small piece of glass, and place the glass standing on edge against the wall. Should it dry in from six to eight hours without being "tacky" when the finger is applied, it may be pronounced a fairly good boiled oil; but, of course, this refers to its drying properties only. Allowance must be made on occasions for varying atmospheric conditions.

Very many methods have been devised by means of which an adulterated oil may be detected. As the specific gravity of linseed oil is lower than that of any of its usual adulterants, it is frequently detected by ascertaining the gravity of the suspected sample. However, in order the more effectually to disguise the adulteration, recourse is sometimes had to a lighter grade of inferior oil, which is so blended with the heavier kind that detection by this means is difficult unless a very careful analysis and specific gravity test are given. The purity of a sample of oil suspected of containing fish oil may be readily ascertained by the application of heat, which, if the sample be impure, will evolve the unmistakable fishy odor characteristic of menhaden and other fish oils.

The most trustworthy test that can be applied to a sample suspected of containing cottonseed oil is based on the well known propensity of the latter to change to a thick, whitish substance when placed in a low atmosphere—a refrigerator or a freezing mixture, for instance. By placing two samples, one known to be pure linseed oil, the other the suspected one, in a good refrigerator or in a freezing mixture, the latter, if adulterated, will thicken as above described, while the pure sample, although thickened to a slight extent, will be found to have retained its color, this striking contrast constituting the test.

A general method of detecting an impure oil, as practiced in German laboratories, consists in the application of concentrated sulphuric acid in the proportion of one part to one or two parts of the oil. On this admixture a very intense action immediately ensues, the temperature rises and the mixture becomes colored. A few drops of the oil are placed on a glass plate having a sheet of white paper beneath. To the oil is added a small drop of sulphuric acid of specific gravity 1·632, when the oil becomes thick and the characteristic dark color of linseed oil will be at once developed, if pure.

The peculiar and objectionable quality called "fattening" which is sometimes present in linseed oil, and which on occasions has a decided propensity to increase in volume and diffuse itself throughout the body of the oil, instead of separating, as the settling period is prolonged, and as all other impurities do under similar conditions, proves a source of annoyance to the consumer. The result is directly traceable to the use of a seed which contains a large proportion of foreign oleaginous matter, such as mustard seed, rape seed, etc., the oil from which, being of a non-drying and viscous or fatty nature, is pressed out with the oil from the linseed by the great hydraulic machine, commingling with and imparting to the latter oil its objectionable properties, thus producing a very inferior article. Where seed is thoroughly screened before being put into the mill hoppers the presence of such foreign seeds or impurities of any kind to an extent sufficient to affect the quality of the oil deleteriously is practically impossible. Therefore, the sure way to guard against such an inferior product is to take the precautionary measure of cleansing the seed. The specific gravity of the non-drying fatty oil being less than that of linseed oil, decantation after a period of repose is of no avail. However, it sometimes occurs that a paint manufacturer is mistaken in applying this title of "fattening" to an oil, the fault resting with his improper manipulation of the pigments and oil during the mixing process. The writer remembers an instance where a vigorous complaint was made by a consumer who purchased one barrel of oil that was drawn from a tank which contained 50,000 gallons, and who positively asserted that it was unfit for use from its undoubted fattening properties; this, notwithstanding the fact that every gallon of the 50,000 had been delivered to various consumers without another solitary complaint.

Oil of this nature is of far less frequent occurrence in this country than in England. In very many instances the superior quality of the oil is not the objective point of the manufacturing process in England.

The great bulk of the seed used in that country is imported from the East Indies, chiefly Calcutta; the seed from the vast territory surrounding the latter city contains on an average 15 per cent. of impurities, a large proportion of the latter being foreign oleaginous matter, such as mustard and rape seed, etc. The manufactured product of such a combination is in every instance an oil possessing "fattening" qualities. The writer has seen many thousands of bushels of seed worked in this manner without any preliminary screening process, in London. The American crusher (at least in the great cities) is much more careful in the preliminary processes necessary to procure a pure oil than the members of the craft across the ocean.

This article would be incomplete without a reference to the quality of oil called "pale boiled." This oil is extensively used; it is free from litharge or lead compounds of any nature, its treatment being more mechanical than chemical, and a light color, as its name implies, being aimed at, it is not subjected to a high temperature. A large proportion of the oil which comes under this heading is accorded very little treatment, the whole operation in many cases consisting of pouring into the barrel of crude oil some worthless compound, and thus completing the operation—whence the term "bung boiled."

Oils boiled with leads, having a deep hue, are unsuitable for special work, sometimes affecting the purity of the white lead, zinc white and delicate tints. Where delicate tints are a leading feature, as in decorative house painting, genuine pale boiled oil is advantageously employed.

A peculiar propensity of linseed oil is its tendency to increase in weight when exposed to the air in a vessel protected from dust. So far as its physical qualities are concerned it undergoes a gradual change, assumes a darker color, becomes more viscous and less inflammable. An experiment made by a Bavarian chemist resulted in 3·5 oz. of pure linseed oil increasing 0·31 oz. in weight after the oil had been exposed to the air eighteen months, an increase of about 8 per cent.

* From *Drugs, Oils and Paints.*

## METHOD OF MAKING STANDARD SPERM CANDLES.

THE metropolitan gas referees have lately issued the following particulars concerning the methods to be adopted in manufacturing standard sperm candles for photometric work:

(1.) All candles to be used in the testing places shall be made with the materials hereinafter prescribed, and shall, when made, be examined and certified by the gas referees.

(2.) The wicks shall be made of three strands of cotton plaited together, each strand consisting of 18 threads. The strands shall be plaited with such closeness that, when the wick is laid upon a rule and extended by a pull just sufficient to straighten it, the number of plaits in four inches shall not exceed 34 nor fall short of 32. Each wick shall be of suitable length and looped ready for fixing in the mould. After having been bleached in the usual manner and thoroughly washed, the wicks shall be steeped in a liquid made by dissolving one ounce ot crystallized boracic acid in a gallon of distilled water, and adding two ounces of liquid ammonia. They are then to be gently wrung or pressed till most of the liquid has been removed, and dried at a moderate heat. Twelve inches of wick thus made and treated shall weigh not more than 6·5 nor less than 6 grains. The weight of the ash remaining after the burning of ten wicks which have not been steeped in boracic acid, or from which the boracic acid has been washed out, shall be not more than 0·025 grain. Wicks made in accordance with this prescription shall be sent to the office of the gas referees, by whom they will be examined and certified. The wicks so certified are to be used by the candlemaker in the condition in which they are returned to him.

(3.) The spermaceti of which the candles are made shall be genuine spermaceti, extracted in the United Kingdom from crude sperm oil, the product of the sperm whale (*Physeter macrocephalus*). It shall be so refined as to have a melting point lying between 112° and 115° F. An account of the method by which the melting point of the spermaceti is to be determined is given in the appendix. Since candles made with spermaceti alone are brittle, and the cup which they form in burning has an uneven edge, it is necessary to add a small proportion of beeswax or paraffin to remedy these defects. We, therefore, prescribe that the best air-bleached beeswax, melting at or about 144° F., and no other material, shall be used for this purpose, and that the proportion of beeswax to spermaceti shall be not less than 3 per cent. nor more than 4½ per cent.

(4.) The candles made with the materials above prescribed shall each weigh, as nearly as may be, one-sixth of a pound, and will be found to answer to the follow-

ing test: Immerse a candle, taper end downward, in water of 60° F., with a brass weight of 40 grains attached to the wick by a small piece of thread. When a further weight of two grains is laid on the butt end of the candle, it will still float; but with a weight of 4 grains it will sink. As the rate of burning of a candle is affected by the force with which the wick is pulled when it is set in the mould, the strain commonly applied by an experienced maker of candles has been measured, and is found to be about 24 ounces. The candles shall be sent to the office of the gas referees, by whom samples from each batch will be examined and tested. Each batch of candles shall be accompanied by a specimen of the spermaceti (unmixed with beeswax) which was used in making them. Packets of candles approved by the gas referees will be sealed by them and certified for use in the testing places.

(5.) The candles are to be used by the gas examiners as heretofore, in accordance with the half yearly "notifications" of the gas referees. The results are to be corrected, as usual, on the assumption that for small variations the light of a candle varies directly with its consumption; and if any candle in a packet certified by the gas referees is found by a gas examiner to burn at a rate exceeding 126, or falling short of 114 grains per hour, the testings made with that candle are to be rejected.

### METHOD OF DETERMINING THE MELTING POINT OF THE SPERMACETI.

As various methods are used by different refiners of spermaceti for determining the melting point, which lead to different results, it must be noted that the temperatures here given as the limits within which the melting point of a sample of refined spermaceti should fall, viz., 112° to 115° F., have been found by the following method, which is known as the capillary tube method:

A small portion of the spermaceti is melted by being placed in a short test tube, the lower end of which is then plunged in hot water. A glass tube, drawn out at one end into a capillary tube about 1 mm. in diameter, is dipped, narrow end downward, into the liquid spermaceti, so that, when the tube is withdrawn, 2 or 3 mm. of its length are filled with spermaceti, which immediately solidifies. The corresponding part of the exterior of the tube is also coated with spermaceti, which must be removed. The narrow part of the tube is then immersed in a large vessel of water of a temperature not exceeding 100° F. The lower end of the tube which contains the spermaceti should be 3 or 4 inches below the surface and close to the bulb of a thermometer. The upper end of the tube must be above the surface, and the interior of the tube must contain no water. The water is then slowly heated, being at the same time briskly stirred, so that the temperature of the whole mass is as uniform as possible. When the plug of spermaceti in the tube melts, it will be forced up the tube by the pressure of the water. The temperature at the moment when this movement is observed is the melting point.

### METHOD OF WASHING WICKS.

As it is found to conduce to the regular burning of candles that the wicks should have been, as far as possible, cleaned and freed from mineral matters, it is recommended that the candlemaker, before steeping the wicks, shall wash them first in distilled water made alkaline with between one and two per cent. of strong liquid ammonia, then in dilute nitric acid containing about ten per cent. of strong acid and then repeatedly in distilled water.

## HOW TO MAKE STATUARY IN PAPER.

A NEW branch in the art of home adornment, which is well worthy of attention, has been wrought by Mrs. Cordelia Shont, of Pittsburg, Crawford Co., Kansas. Our notice was first called to the work of this artist by Mrs. A. N. Leigh, of the same place, who sent us a photograph of the originals from which our engraving has been produced. The principal example is a graceful statue of a female figure, made of paper, and there are also vases and chairs. Our engraving hardly does justice to the statue, which is quite an artistic production. As all these specimens are of home manufacture, we have thought it would be interesting to our readers to learn from the author herself how they were made, and we accordingly give the following account, which Mrs. Shont has kindly furnished to us:

"You will see by the photograph that the principal piece of work is a statue, the title of which is 'Surprised at the Bath.' The expression is intended to be one of displeasure. It is five feet high, weighs ninety pounds, is made of waste wrapping paper and flour paste, and finished with several coats of white lead.

"There are three vases and two chairs made of paper, which have been in use for nearly a year, and have not suffered from use.

"The statue is solid. There is a wire frame for the limbs and head. I wound it with stout cloth strings, wet in flour paste, let it dry until firm enough to stand. Then I put on the paper until it was the desired shape and size, always letting it dry after going over it with two or three thicknesses of paper wet with paste and well pressed down with my hands. When I get too much on in one place, I whittle it off when dry. Of course, the more nearly correct it is made in the first place, the less work there will be to make corrections.

"Taking everything in consideration, I think paper is the best material for working out one's ideas in art or ornament that has ever come in use, because every one can get the material, and if we fail or make a mistake, or wish to change, we can do so without losing all of the work. After I had the statue nearly done, I changed it by sawing the neck and waist in to the wire, then turned and bent in the shape desired, cut out some wedge-shaped pieces of paper, and pasted them in the cavity until it was all solid and firm as ever.

"The chairs have wire frames tied where the wires cross, with strings wet with paste, then filled and pressed in between with paper till even with the wire, and as much more as desired. Pieces of stout cloth are good where increased strength is required, always finishing with paper. The paper can be rasped to make it straight. Sandpaper and oil paint make a good finish

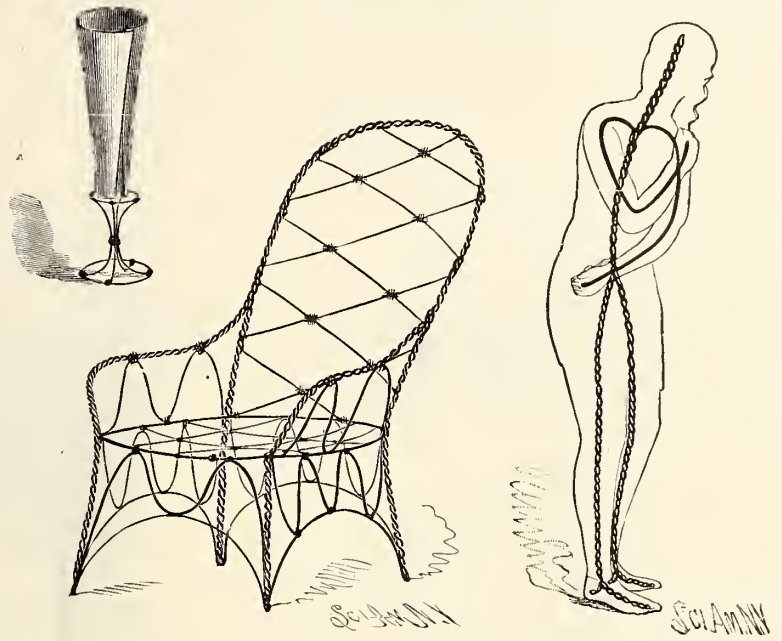
"The vases are made by cutting paper and sawing or pasting it in shape. It is best not to put too much paper on at once, but dry often.

"I commenced the statue in June, 1886, and had it ready for the fair in October. It might take longer to make one in marble. In paper we can try as often as we please to improve the expression. Marble may always be considered the best in art, but paper has a great many advantages. It can be knocked about with little care, and if broken can be repaired. I executed this work and hardly missed the room it took in the house. It is light and easily carried and stowed away anywhere, when I had other work to do. I never would have had a chance to do in marble what I have and can do with paper, and that may be the case with many others.

"I send three sketches; the heavy lines, five in number, in the statue represent the length of the wires. They can be bent any shape to suit. It is easier to make the hands and ears separate, then fasten in and finish afterward. The feet must be made solid at first, or they will not bear the weight if moved while damp with new paste.

"The crosses in the chair show where the wires are tied with pasted strings. Then paste on and fit in as stated before.

"A cone-shaped paper is all that is necessary for a straight vase; for a very slim stem, a wire frame will make it so stout there will be no danger of breaking."



## CARRIAGEWAY PAVEMENTS.

UNLIKE many technical questions, the construction of our roadways is of direct interest to every one, whether engineer or street arab, though what particular class of pavement is most in favor with the latter no one has yet thought it worth while to inquire.

As for the small boy, sufficiently high in the social scale to rejoice in the possession of a pair of roller skates or a bicycle, there is no doubt that his vote would be given in favor of asphalt. As yet, however, no party has risen in the state to claim for this class a voice in municipal matters, and his likes and dislikes may therefore be disregarded. It is hard to say what the earliest pavements may have been made of, whether of wood or stone. Certainly, if one judged by the vestiges of old-world civilization yet remaining, it would be natural to conclude that the use of wood as a paving material was unknown to the ancients. Nevertheless, it is not at all unlikely that the first attempt at a pavement was the laying of logs side by side to form a corduroy road, in the manner still common in the wooded districts of our colonies and of parts of the United States.

This is, of course, a very different method of using wood from that practiced in modern cities, where the real pavement is the concrete foundation, the wooden blocks merely constituting a wearing surface. In fact, in most good modern pavements, whether in macadam, wood or asphalt, the real pavement is the foundation, on which is laid a more or less easily renewable covering taking the wear.

Set pavements are, however, an exception, the blocks being frequently laid on a thin layer of sand or furnace ashes. The art of constructing a good pavement was thoroughly understood by the Romans, some of whose pavements are still in use in Italy. It is remarkable how long a time elapsed before decent pavements began to be laid in England. It is well known that our ancestors can scarcely be said to have enjoy-

HOW TO MAKE PAPER STATUARY.

ed (?) the possession of a nervous system, but if additional proof were required, it is afforded by their long and apparently uncomplaining endurance of the torture of the cobble-stone pavement. As Sir Benjamin Baker reminded the meeting at which Mr. Isaacs' excellent paper on the subject was read at the Society of Arts, it was in 1762 only that the first granite set pavement was laid in London, the old pavement being cobble stones. Of course the traffic was nothing like the present in amount, but even a single light trap driven at a high speed past one's windows over cobbles is quite sufficient to interrupt conversation for the time being.

Possibly this fact may account for the taciturnity so commonly attributed to Englishmen in those days and which certainly has diminished of late years, though it would, perhaps, be going too far to credit this possibly questionable improvement to the great advance which has been made in the art of paving during the past century.

The benefits of a good pavement are of a somewhat indirect nature. The average man, no doubt, sees that horse and vehicle owners do gain an advantage in the lessened traction; but his own interests, save in the matter of noise, do not appear so directly, as the decrease in the cost of goods, owing to their more easy and rapid handling, only makes itself felt comparatively slowly. There is thus, particularly in new countries, a disposition to economize in the matter of paving. Something, however, can be said in defense of this.

Towns in new countries are practically invariably laid out with excessively wide streets, the satisfactory paving of which is far beyond the resources of the young community. It would be far better in such cases to pave only a portion of the road thoroughly, in place of, as is so often done, to pave the whole of it in an indifferent manner.

There is a consensus of opinion that granite sets, properly laid, make the cheapest pavement of any. It is also comparatively hygienic, and no system is so well adapted to the laying of that modern abomination, the tram rail, which, however useful and necessary it may be in providing a cheap, if somewhat slow, means of communication between a city and its suburbs, should find no place in the heart of the city, in the crowded streets of which the cars still further obstruct the already congested traffic. Where, however, tram lines are to be laid, there is no doubt that it is easier to maintain the surface of a stone pavement than any other. Its principal disadvantage is its noise, but it is also liable to become slippery by wear, and in Continental cities there is another objection to it, viz., the splendid material it affords for the construction of barricades.

No act of Napoleon III. showed greater astuteness than the laying of the Paris streets with asphalt, which may claim the credit of being, of all paving materials, that least adapted to the requirements of the rioter. Since the inauguration of the republic, wood seems to have been more or less replacing asphalt in the Paris streets; and in spite of the many serious objections to it, it has apparently become the favorite material in London. Its only advantages seem to be that it is the least noisy of all pavements, and that, though very slippery, a horse when he falls can rise comparatively easily, and is not so likely to be injured. From a pedestrian's point of view it is only less objectionable than granite, because of the noisiness of the latter. In dry weather it stinks, and in wet weather it becomes covered with a liquid filth, which, by passing vehicles, is sure to get splashed into the face and over the clothes of the unfortunate pedestrian, unless the footpath happens to be wide and he is able to hug the house line pretty closely. When in good condition, the traction on it is no doubt low, but it is difficult to believe, when in the state into which it is sometimes allowed to get, that it has then any advantage over granite. It requires renewing at shorter intervals than either granite or asphalt. Indeed, where the traffic is very heavy, six or seven years seem the limit of life, though in more favorable conditions this may be extended to ten. Under average conditions the Improved Wood Company claim a life of nine years. The renewal of the pavement in an important thoroughfare is a serious matter, causing great annoyance and obstruction of business, and, other things being equal, the longest-lived pavements should invariably be chosen. Unfortunately other things are not equal, and as there is not the slightest likelihood of a general adoption of rubber tires for vehicles, it is probable that wooden pavement will be greatly extended within the next few years.

Apart from its slipperiness and cost, asphalt makes an ideal pavement. It is somewhat more noisy than well-laid wood pavement in good condition, but the noise is both less in amount and more agreeable in character than that of set pavements. Indeed, on asphalt the noise is mainly due to the beat of the horses' feet, and has sometimes an almost musical ring; further, there is a complete absence of the nerve-tearing rattle due to the bumping of a heavy wagon from one set to another, or in and out of the holes which soon form in badly maintained pavements of both wood and stone. Such holes certainly form in asphalt, too, but there is no pavement in which they can be so easily and so efficiently repaired. From a hygienic point of view, it stands far in front of all competitors, its absolute imperviousness affording no permanent lodgment for filth, and no pavement can be so easily cleansed. As regards its slipperiness, this can be greatly diminished by proper attention. In Berlin, Mr. Isaacs informed us, it is the favorite pavement, and is not found to be specially unsafe for horses. Berlin, it must be remembered, has a much severer winter than we have, and hence it should be more difficult to render it safe for horses than it is here. The secret of the success attained is to be found in keeping the asphalt perfectly clean. Clean asphalt is not slippery either wet or dry, but every one knows how commonly horses fall on it in London when rendered greasy by a shower. In Berlin the asphalt is thoroughly washed every morning, and, should a good shower of rain fall during the day, the cleaning gangs reassemble and wash it again.

Naturally, with the narrow streets so common in the City of London, there is a much greater concentration of the filth in the roadway, but there is no doubt whatever that better results could be obtained if sufficient pressure were put upon the authorities. Our experiences in this country have been almost confined to natural asphalt, the artificial ones not being in favor, owing to the belief that in crossing a street paved with them in hot weather the pedestrian is likely to leave his boots behind him on the way. The earlier attempts at artificial asphalts were certainly open to this objection, but the difficulties appear to have been overcome in America, where the Barber Asphalt Company have laid some six and a half million square yards during the past fifteen years.

Of other forms of pavement, macadam is, no doubt, the safest of any, so far as horses are concerned. It is, however, extremely dirty in wet weather, and excessively costly to maintain, if the traffic over it is at all dense. In short, macadam has no business in the streets of a large city, and why it is still used along the Thames Embankment is a mystery to which we do not possess the key. In the United States brick pavements have been largely laid during the past few years, with, it is claimed, very satisfactory results. The bricks in question are of a special type, having great density, hardness and strength. Many of the bricks used have an average crushing strength of 450 tons per square foot, or about the same as Staffordshire "blues," and special samples have, it is stated, only failed under three times this stress, or upward of 1,300 tons per square foot—*i. e.*, superior to many granites. Of course the crushing strength of a stone is in itself but an indifferent criterion of its merits as a paving material, but it is certainly one element of importance, and the bricks in question are claimed to wear well under traffic.—*Engineering.*

## THE VALERE RUNNING MACHINE.

At the coming International Exposition of Velocipedy at Paris there will be exhibited a machine of a very peculiar model, the bicycle of Mr. Valere, a Frenchman. Up till then the invention will be kept somewhat in the shade by Mr. Valere, but despite the precautions taken, the indiscreet are nevertheless already anticipating a great renown for it.

There is one fact that puts the curious on the *qui vive:* A month ago, Mr. Valere, starting out upon his bicycle for the eighth time only, and meeting in the Bois de Boulogne the racer Farman, the 100 kilometer champion of France of 1892, challenged him to a trial of speed to be made at once. The matter was immediately arranged, and the race was begun. Upon a stretch of 300 meters, Farman was distanced by three lengths. He stopped with lungs exhausted through the spiritedness of the running. The news, immediately disseminated through the journals devoted to bicycling, was verified, and recognized as true. Was it the announcement of a revolution?

The Valere machine is of almost ingenuous conception. It adds, upon a simple bicycle, the work that the arms are capable of furnishing to that which the legs furnish. The arms aid the legs in their rotary motion. That is all.

But the originality of the system does not reside in this. A great number of inventors have conceived the idea of utilizing the arms in bicycling, either as the principal motor or an adjunct one. In Germany alone there exist more than two hundred patents relating to this question. The originality of the Valere system consists in the very ingenious mode of application of these two species of motors to the same toothed wheel. The one who rides upon this machine executes natural motions only—*those of a man in the act of running,* hence the name bestowed upon the apparatus, the "running machine."

Mr. Valere, who is a painter in enamel of great merit, is likewise a celebrated oarsman who at intervals has already won more than eighty first prizes in boat races. When he for the first time made the acquaintance of a simple bicycle, in July, 1892, he, who was accustomed to the hard work of the arms that the oar and paddle required, was surprised to see the inaction that, in bicycling, is inflicted upon our upper limbs, which are nevertheless so vigorous. He immediately conceived the idea of a machine that should utilize these slighted limbs and endeavored before all else to construct a rational apparatus, that is to say, one that should not counteract the natural motions of a man in the act of walking. He took for his model the foot race with an ambling motion, suggested by figures on Greek vases. If such motions of the ancient athletes be roughly analyzed, we find that, when the right leg is moved forward, the right arm immediately moves with it in the same direction, while the left leg and arm remain behind, and reciprocally. What is done in the Valere machine? The right leg bearing upon the pedal, the right arm pushes the right hand lever, while the pedal to the left, that is to say, the left leg, rises behind and the left arm pulls the lever to the left toward the body, and reciprocally.

The motions that this apparatus requires are therefore natural—*instinctive* even. This is the important point that distinguishes the Valere patent from former patents treating of an analogous question, and that decides in its favor. It is herein especially that resides the value of the invention.

Mr. Valere in the first place constructed a tricycle whose weight, certainly 36 kilogrammes, in no wise approached that of our ordinary three-wheeled machines, which often weigh but 16. Nevertheless, upon this heavy apparatus, without any practice on the track and without any training, and despite a very legitimate apprehension of the sloping curves that he met with for the first time, and in consequence of a fatal retardation of speed at these difficult points, Mr. Valere made, upon his first visit to it, the round of the Seine Velodrome (500 meters) in 45 seconds. The distance made by the apparatus at every complete revolution of the pedal was 7 meters, while our tricycles make scarcely more than 5·25.

The Valere tricycle is the machine that many inquisitive people have already seen, and that some have even ridden by way of trial; but the bicycle has as yet been exhibited to but a very small number of amateurs, upon remote roads, and has not yet been described.

Fig. 1.—THE VALERE RUNNING MACHINE.

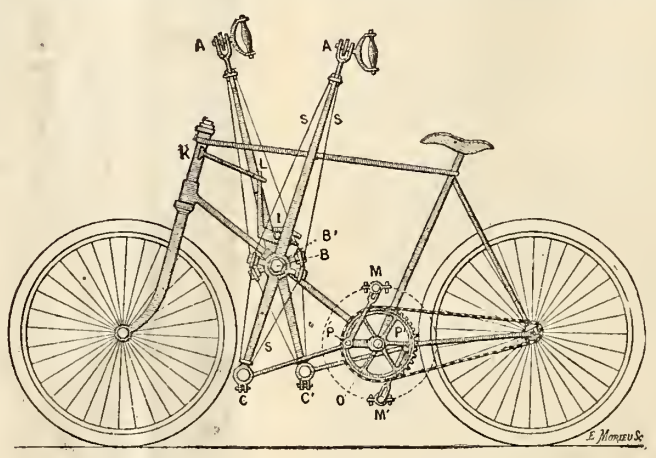



Fig. 2.—DIAGRAM OF THE VALERE MACHINE.

A B C and A' B' C', levers; C P and C' P, connecting rods; M and M', pedals mounted upon the cranks, M P and M' P'.

We shall here give an explanation of it in a few lines that are unfortunately incomplete and necessarily somewhat dry.

The running machine has the aspect of an ordinary bicycle. Its frame, however, is more elongated. Upon the lower tube of this frame that connects the head with the crank arms are mounted two levers, A B C and A′ B′ C′, formed of tubes strengthened by tension rods, S. The joint is situated at the point, B. These levers act upon the sprocket wheel through small connecting rods, C P and C′ P′. There are, therefore, joints at these four points.

The pedals, M and M′, are mounted upon cranks, M P and M′ P′, which are not, as usual, keyed to the center of the sprocket wheel at O, but at P and P′, that is to say, at the points worked by the levers. But, since the angle, M P O, is constant, this arrangement, necessitated by the exigencies of the construction, is equivalent to a crank of the length, M O. How is the steering done? The steering gear, most certainly, is not the most commendable part of the machine, and Mr. Valere finds no difficulty in acknowledging the fact. We briefly indicate, transferred to the bicycle, the steering gear that the inventor has applied to his tricycle, but which he will have changed in a month for the Exposition. It is here merely a diagram.

The steering is done by means of racks that cause the ascent or descent along the levers of two sliding boxes, into which are inserted the extremities of a horizontal lever, the profile of which is seen at I. Upon the center of this lever is brazed at right angles a second lever, which, at L, controls, in a slide, the steering bar brazed at K, upon the head of the machine.

It will be seen, then, that upon turning the handles of the levers, the rider causes, for example, the ascent of the slidebox, which takes in the extremity, I, of the horizontal lever, and consequently raises this point, I, causes the second vertical lever to incline to the right, and thus causes the steering wheel to turn to the left.

All this is certainly complicated, and the best of our present bicyclists would have to take three or four lessons of an hour's length before feeling somewhat at ease upon this machine. But Mr. Valere's remarkable invention is not impaired by this detail, which is important, but not fundamental, and which the manufacturers will be able to improve.

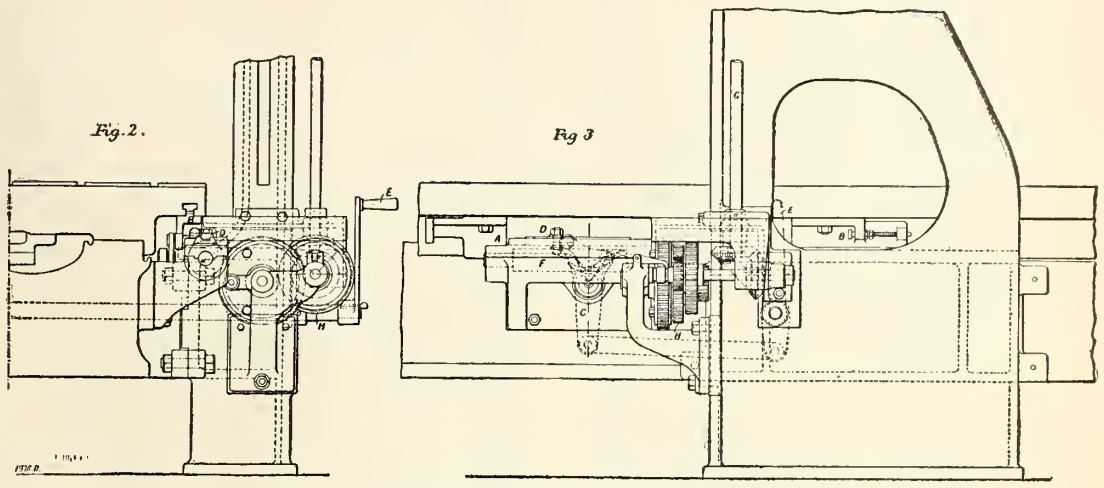
What results have been given up to the present by the running machine? Very good, but yet incomplete ones. The Valere tricycle, ridden by the inventor himself, has beaten all the racers in Germany who have competed with it. In France it has conquered several fine wheels. But, in order to be exact, it must be acknowledged that no very regular test has as yet been made. Mr. Valere has always ridden his machines himself, and he is not a racer, but far from it! He cannot as yet, moreover, have got used to an apparatus the construction of which was finished but a month ago. It will, therefore, be necessary to wait, in order to see all the merit of this invention, in which we have full faith, for the return of fine weather, in the first place, and then for the riding by a true racer, who has been well broken in to the new simultaneous exercise of the arms and legs.

Our ordinary bicycle, at every revolution of the pedal, makes a distance of 5·75 meters. That of Mr. Valere makes nearly 8 meters without the least supplementary fatigue to the rider. A machine for the track that will make 10 meters is now in course of construction.

In the present state of cycle construction such figures ought to make experts incredulous. And yet here is a machine that we have seen running upon soft roads (unlike so many inventions that operate in theory, upon paper) and that passed before our eyes like a little locomotive upon which a man in comfortable attitude was trotting along at a great racing pace. We hope that the coming experiments will demonstrate all its superiority to our present types.—*La Nature.*

## IMPROVED PLANING MACHINE.

THE planing machine which we illustrate has been constructed by Messrs. Sharp, Stewart & Co., of the Atlas Works, Glasgow, and in general design, says *Engineering*, is similar to the machines made by this company for a number of years. This is in particular the case with the driving gear, which consists of a rack below the table, gearing with which is a pinion having helical teeth. The teeth are machine-cut, and a very smooth motion is attained. The wear also is small, as, though upward of one thousand machines with this type of gear have been supplied by the company, in no instance have they yet had to replace either wheel or rack. The machine is very rigidly constructed, and it is claimed that higher speeds than were formerly possible can be attained in both the cutting and return strokes, there being an entire absence of shock and vibration. Its feature of special interest is, however, the feed motion (Robinson & Oldfield's patent) with which it is fitted, the arrangement of which is shown in Figs. 2 and 3. In this A and B represent tappets attached to the table of the machine in such a way as to strike the reversing lever, C (Fig. 3), and the feed tappet, D, which are perfectly independent of each other, thus reversing the machine and actuating the feed mechanism at the same time. Owing to this arrangement, the machine can by means of the handle be stopped, started or reversed without moving the feed gear at all. Thus, if any accident happens to the tool, it is only necessary to move the lever, E, to stop the machine, and there is no risk of putting in a cut accidentally while bringing the machine to a stand. The feed tappet, D, is carried by a slide, and on the top of the stud fixing the tappet there is a hardened steel runner or die, which engages with a helical cam, F. As D is moved to the right or left, this cam revolves and actuates the vertical shaft, G, through the feed gear, H. This shaft, G, operates the feed screws of the tool boxes. The tappet, D, is adjustable in its slide and can be arranged to receive an impetus either from A or B, and either sooner or later in the stroke of the table, thereby giving a variable feed, the range being from $\frac{1}{32}$ in. up to $1\frac{1}{2}$ in. The change from one rate of feed to another is very quickly made. The feed is "put in" in as short a travel of the table as in the ordinary mechanism, and there is no drag of the tool over the work in the return stroke. The machine shown in the engravings can plane castings, if necessary, 4 ft. by 4 ft. by 10 ft., and the feeds can be given either up or down, right or left, and at any angle. In all cases the feed is "put in" at the end of the return stroke.




IMPROVED PLANING MACHINE.

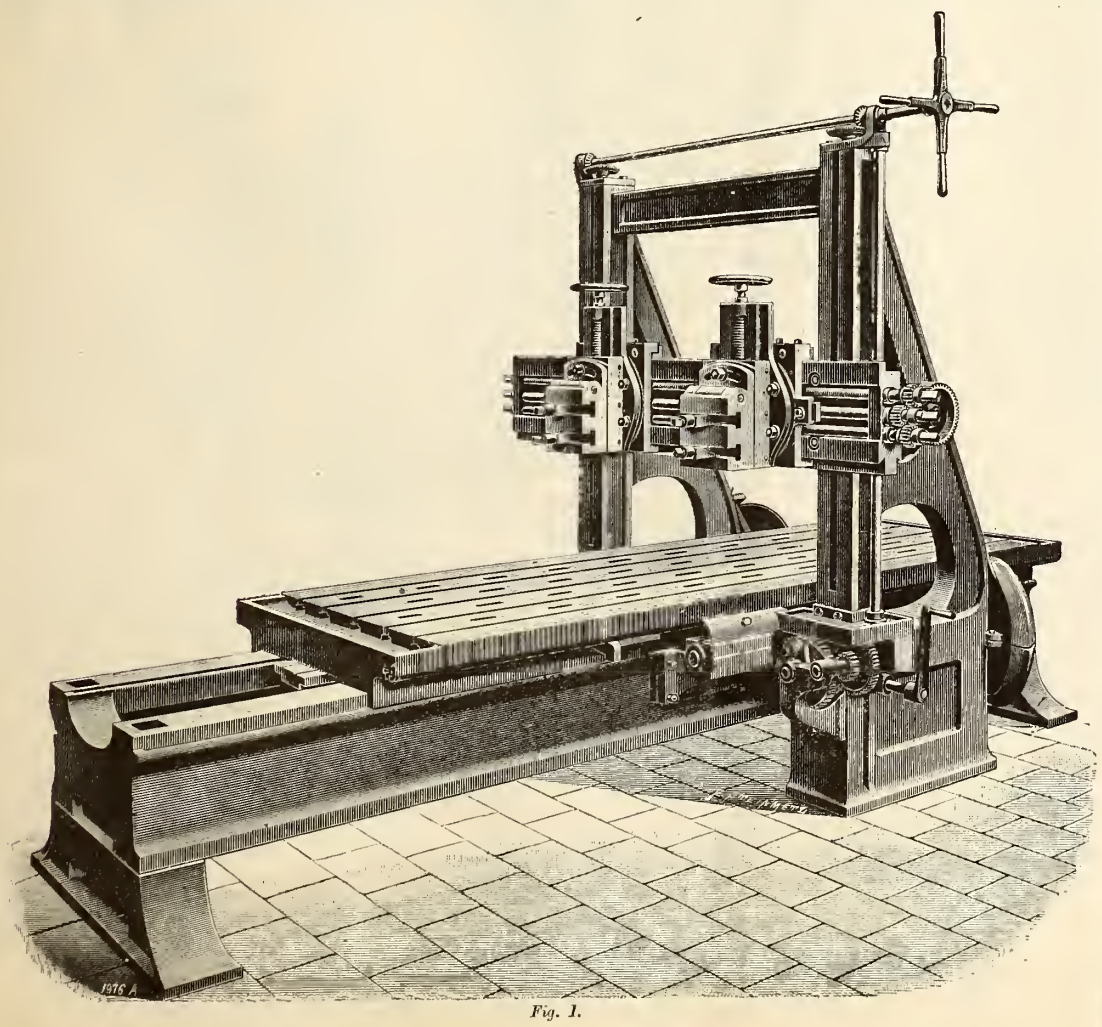


*Fig. 1.*

IMPROVED PLANING MACHINE.

## METALLIC LANTERN SCREENS.*

By W. H. HARRISON.

ONE portion of the recent invention by Mr. Anderton in relation to lantern stereoscopic projection may have the effect of drawing more attention to the subject of screens. The photographic society might have done well to settle certain points while it had the silver-faced screen in use, for brilliancy of image is one thing, perfection of color is another.

Should the image have too metallic a luster to be altogether pleasing, the invention may yet lead to improvement of the ordinary images should a screen with semi-metallic luster be found to increase the light, without deteriorating the color of the picture. By semi-metallic we mean a luster something like that of artificial pearls, which consist of large hollow glass beads coated inside with fish scales ground up in a suitable medium, with which medium a screen might be painted.

The great founder of photography, Nicephore Niepce, lived near the little town of Chalons on the Saone, one of the best of the Continental seats of the industry of making artificial pearls, which pearls were invented by a Frenchman of the name of Jaquin. The scales of the bleak—a little fish common in the Thames, the Rhine, the Saone, and in most rivers of Europe—are thrown into a solution of ammonia, which helps to preserve them on the one hand and gives them a degree of softness and flexibility on the other. The liquor employed to make artificial pearls is an article of commerce, known as *Essence d'Orient* or oriental essence. The chief of the few seats of the artificial pearl industry are in France, but there are a limited number elsewhere. The products differ in quality.

Before quitting this fishy subject, some lantern effects may be noticed which were produced some years ago at an exhibition of articles of luxury in Nice, during the English season there. One of the rooms connected with the exhibition was normally kept in darkness, but its walls formed an aquarium, behind the glass sides of which were numerous fish with silvery scales, common in the Mediterranean. Out of sight, above the tanks, were electric lanterns, casting their beams upon the silvery sides of the fish, so that the room was chiefly illuminated by means of these living mirrors, moving restlessly to and fro, and casting flashing beams of light among the spectators. It was a pretty fantasy, eminently French in its conception and execution.

In making artificial pearls, sometimes the lustrous matter is suspended in gum, and the outside of the little glass globe containing it is deadened with hydrofluoric acid.

An opening seems to exist for experiments to determine the best surface for a lantern screen between that of dead white and metallic luster.

Supposing dead metallic screens to be advantageous for ordinary purposes, the Germans have been clever in making "silver paper" of tin, which is economical. This paper is used for wrapping tea and edible articles, consequently, under the German law, it must not contain more than one per cent. of lead. The full details of the manufacture of this paper had been kept somewhat a trade secret, until Herr A. Harpf gave the particulars in a German periodical; an abstract of his statements appeared recently in the Proceedings of the Institute of Civil Engineers. Herr Harpf was for some time in charge of a manufactory of the "argentine," as the tin deposit is called.

The manufacturers start with a solution of tin in hydrochloric acid, and get the metal from waste tin materials, such as bearing-metal turnings from railway repairing shops. For lantern screens it would be cheap enough to start with already purified stannous chloride, which should be placed in vats in which plates of zinc are suspended, when, if all conditions are right, the tin precipitates as a gray spongy mass,

* Abstract from the *Magic Lantern Journal.*

and hydrogen is evolved. The spongy mass is dried, and rubbed through a sieve to a fine dust. The author says that two methods are employed of coating paper therewith: "In the first, 4 kilos of wax, and three-quarters of a kilo of potash are boiled with 50 kilos of water, and the melting fluid so produced is stiffened to a thick paste by stirring the tin precipitate into it. In the second, 75 liters of freshly made 4 per cent. starch solution are mixed with 750 grammes of a wax solution, prepared from 5 lb. of wax and 1½ lb. of potash dissolved in hot water, and 25 kilos of argentine are added. The paste so obtained is printed by rolls on to paper, which dries to a dull gray tone, but becomes bright when burnished by passing between hot calendar rollers, when it exactly resemble tin foil." What is wanted for Mr. Anderton's lantern screens is a state of brightness midway between the two extremes just mentioned.

Real silver paper is sometimes made by covering white paper with a priming of white lead and size, and cementing silver leaf thereupon.

The powdered aluminum of different degrees of fineness now obtainable in the market seems to be about the best substance for use in experimenting in the direction now under notice, especially as it is not attacked by sulphur in the air. Used pure, it perhaps gives as high a metallic luster as will ever be required, and its luster may conveniently be reduced, if necessary, by admixture with a suitable white substance, preferably sulphate of barium, which is practically unchangeable. The powders can be applied as a paint in any suitable vehicle, such, for instance, as size. The Lantern Society might do useful work in experimentally investigating the merits of different semi metallic screens.

## FIREPROOF FLOORING.

WE propose in the following lines to give a few data in regard to the various systems of fireproof flooring employed in Europe and the United States.

*A Few Examples of the First Fireproof Floors.*—The oldest known attempts made in England to render floors incombustible were those due to the builders of Nottinghamshire and Derbyshire, who employed plaster. In 1766, David Hartley constructed a fireproof house upon the territory of the parish of Putney, and, in the presence of the King of England, the court and the lord mayor, the lower story was filled with inflammable materials, which were set on fire, while the inventor and some friends remained in the upper story. The experiment was so successful that the English Parliament voted the inventor a gift amounting to $12,500 and extended his patent thirty-one years. Hartley's method consisted in fixing incombustible plates above and below wooden floors, and filling in the space between them with dry rubble and sand. This inventor, however, had but few imitators.

The oldest form of incombustible floor was the brick vault, the springings of which rested upon metallic girders, and the first known example of this application is that of Phillips & Lee's works, at Manchester, built in 1811. The girders were of cast iron, spaced 10 feet apart. This system was generally adopted in the construction of stores and cotton factories, and is still employed in our day, with the only difference that girders of rolled iron have been substituted for those of cast iron. The regulations for the structures erected in a large number of English cities even specify the use of this kind of flooring, and it is only by an ingenious interpretation of the clauses of the conditions of the permit that any one succeeds in substituting more improved systems for it.

Messrs. Woodhouse & Potts have modified the system by having cast in a piece, on each side of the girder, frames upon which rest small rolled beams spaced 30 inches apart, and supporting the brick vaults laid in segments (Fig. 1). In another system, due to Mr. Scott (Fig. 2), the panels are generally 10 feet in length, and, with the columns, are cast in a piece with the corbelings, to which are bolted small rolled beams rendered rigid against each other by means of cast iron girders. It is upon the small beams that the brick vaults rest. Although in this system a saving is gained in brick masonry, a large part of the iron work is left exposed—a serious defect in case of fire.

Sir William Fairbairn has devised a form of flooring (Figs. 3 and 4) in which the intrados of the vault consists of flat irons ¼ of an inch in thickness, spaced 36 inches apart and connected with each other by means of $\frac{4\times2}{3\times0}$ T-irons. Cross braces spaced 9 feet apart are fixed to the summit of rolled irons spaced 10 feet apart. The space between the flat irons and the level of the flooring is filled in with beton. The flooring is afterward constructed, as desired, of flag stones, tiles, wood or cement. A modification of this system has been proposed by Mr. Moreland, who employs corrugated instead of flat iron (Figs. 5 and 6). The objection has been made to this and the preceding system that they are exposed to a rapid deterioration through humidity.

With the object in view of reducing the great weight of floors formed of ordinary brick vaults, Sir William Fairbairn, in 1854, employed floors of hollow bricks in the construction of the Saltaire Mills (Figs. 7 and 8). The cast iron girders are spaced 10 feet apart. The vaults have a pitch of 6 inches, and the hollow bricks are 9 inches in height at the springings of the vault (Fig. 6) and 4½ inches at the key. The space above, up to the level of the floor, is filled in with lime and cinders, and the floor is of flags or tiles. Hollow bricks, known in England by the name of "arch pots," were employed on a large scale at a certain epoch. They were used, for example, in the construction of Buckingham Palace, of some of the floors of the National Gallery, of the buildings of the English Treasury, of the United Service Club, as well as for the cupola of the Bank of England (Fig. 9). Fig. 10 gives views of these arch pots on a larger scale. The span of the vault was generally 6 feet, and never exceeded 7. The pitch was less than 6 inches. The pots were 8 inches in height and 4¾ inches in width at the top and bottom. The sides and lower surface were notched in each pot to allow the mortar to enter.

The floor of vaults formed of bricks seems to have been abandoned for the first time by Dr. Fox, of Bristol. The system of flooring due to this inventor, and improved by Barrett in 1853, is known as the Fox & Barrett system (Figs. 11 and 12). It is formed of small rolled beams, spaced 20 inches apart and resting upon the main girders, and of wooden ashlering of one inch section placed upon the lower chords of the small beams at 1½ inches distance from each other. Above the ashlering and between the small beams beton is run in, the ceilings being constructed as usual, and the floor being of flags, tiles or wood, as may be desired. This is the first system in which an endeavor has been made to protect the iron girders. It was applied in the construction of the Liverpool Exchange. For the construction of the roof the system was modified according to the suggestions of a foreman. Instead of wooden ashlering, he proposed to place triangular hollow tiles (Figs. 13 and 14), which, while diminishing the weight of the floor, increased its strength and possessed a greater refractory capacity, due to the nature of the materials and to the air confined in the tiles. Moreover, the beton above could be run in without making use of centerings. Mr. Barrett gives the following mean weights: Wood floor, 35 to 40 pounds to the square foot; floor of the Barrett system, 75 pounds to the square foot; brick vault of 365 feet, 68 pounds to the square foot; brick vault of 730 feet, 115 pounds to the square foot.

The floor proposed by Mr. Clark Bunnett is a flat one of beton, slightly resembling that of the Fox & Barrett system, the wooden ashlering being fixed to the upper chords of the small beams by means of cramps, and the beton being run in up to the level of the ashlering. A layer of cement is spread over the beton and the planks forming the floor are fixed to the ashlering.

In 1862 Mr. Allen took out a patent for a special beton composed of Portland or other cement mixed with fragments of blast furnace coke or furnace bricks in the proportion of one part of cement to six parts of the other materials for a strong beton and one to eight for ordinary beton. He used it instead of stone for floor vaults and for other parts of edifices. At the time of a great fire which in 1871 consumed a six-story house at Finsbury, and all the stone and wooden portions of which were destroyed, some lintels constructed of the Allen beton were in nowise affected by the intense heat.

One of the oldest floorings in which the problem of a metallic construction with girders was realized is due to Mr. Whichcord, who, in 1873, proposed a special framing of fire bricks that surrounds the web and lower chord of the iron girder, as shown in Fig. 15. The blocks were about 738 feet in length, and their form permitted of utilizing them for the bed of the first voussoir of the vault. The bricks, as well as the blocks in question, were fixed in cement, care being taken to give them the possibility of expanding. This inventor constructed an experimental furnace 15 feet in length by 11 in width and 5 feet in height, against the walls of which were supported the lateral vaults, thus representing as well as possible the small vaults of a floor. The latter was loaded uniformly with 6½ tons, which represents a quarter of the breaking load of the bricks. Afterward a very intense fire was lighted in the furnace and was kept up for two hours and a half, when the bricks were suddenly sprinkled with water. The girder was deflected 1¼ inch while it was heated, but resumed its normal position after cooling. It was in no wise damaged, but the bricks were vitrified. A second experiment was made, after the furnace had been reconstructed, in submitting the floor to a very intense heat for an hour and a half, and to a medium fire for 27 hours, after which it was cooled by a stream of water. The result was again very satisfactory; the fire bricks were in nowise damaged and the small iron beams remained perfectly straight and sound.

Mr. Archibald Dawnay has devised a system of flooring consisting of a solid block of beton placed between the small beams of a flat ceiling. Flat irons of one-half inch section, spaced 12 inches apart, or small beams of 3 inches section spaced 18 inches apart, are laid upon the lower chords of transverse girders, which, for an interspace of 7 feet, must have a height of 5 inches. Beneath the girders are laid flat irons, and a beton composed of Portland cement and fireclay is run in. The floor and ceiling may be established as desired. The various arrangements are represented in Figs. 16 to 18. The weight of a floor for a span of 12 feet is about 40 pounds to the square foot.

A modification of the Fox & Barrett system, due to Mr. Phillips, has been employed by the Measures Brothers since 1862. These floors are of beton, and, instead of small wooden beams, T irons, spaced 9 inches apart, are used (Figs. 19 and 20).

In more recent constructions (Figs. 21 and 22), light rolled girders are laid in beton. The floor boards are placed upon small wooden beams fixed to the upper surface of the block of beton, a stratum of air being left between the beton and floor, this, according to the inventor, preventing rot and deadening the sound. The drawback to this system is that many metallic pieces remain without protection against fire.

Messrs. Homan & Rodgers have taken out several patents for fireproof floors. The first, dating back to 1865, consists of a beton vault of a normal span of 10 feet. The objection made to this system is its great weight, which is about 1½ pounds to the square inch. The following patent, taken out in 1871, has for its object the flat type (Figs. 23 and 24), in which small iron or steel beams are laid in beton. The weight per square foot of a floor 20 × 10 feet thus formed is 54 pounds. The third patent, delivered in 1885 (Figs. 25 and 26), concerns the use of special hollow bricks laid upon small rolled beams that carry the beton, the latter being laid without the use of centerings.

This system resembles that employed in the construction of the Commercial Exchange of Liverpool (Figs. 13 and 14).

Messrs. W. H. Lindsay & Co., of Paddington, have adopted an effective combination between iron and beton, the floor and ceiling being flat.

The dimensions of the small rolled iron or steel beams, as well as their distance apart, depend upon the span and the load. They are rendered rigid by means of rods (Fig. 27) passing alternately above and below the beams at intervals of about 18 inches. The entire metallic part is afterward embedded in beton composed of coke dust, sand and Portland cement. The advantage of this system resides in the fact that the iron rods increase the strength of the floor, and, besides, support the beton in its position. In another type of floor advocated by the same builders the stiffening rods are suppressed and the beton assumes the form of flags (Fig. 28).

A patent giving provisional protection was delivered in 1866 to Mr. Richard Moreland for his invention of a type of floor (shown in Fig. 27). It consists of lattice girders resting on each side upon a column and extending from one end to the other of the edifice. Transverse bowstring girders, formed of angle and flat irons, are each of them fixed upon a column. The columns are spaced about 3¾ feet apart. The whole is afterward encompassed by a solid block of beton, which constitutes a floor possessing great strength. The advantage of this system is that the beton is in the form of a single block.

A strike having taken place among the carpenters of Paris in 1840, contractors conceived the idea of substituting iron and beton for wood in the construction of floors. The system of Vaux and that of Thuasue were then generally adopted. The first consists of flat irons curved at their extremities (Fig. 31) and resting upon the walls. Upon these irons are laid rods of square section that carry transverse rods. Flat centerings are placed beneath and the beton run in completely surrounds the metallic structure. In the Thuasue system, small rolled beams slightly curved and spaced 24 inches apart are used. These are connected at about every 36 inches by cross pieces of flat iron whose extremities are curved above the upper chord of the girder, and upon which are placed square rods as in the Vaux system. The beton is run in in the same way. In both cases the ceilings are finished in plaster, and the floor may be formed of any kind of material desired. This system was adopted in the construction of a part of the flooring of the Louvre.

Another process generally used in Paris consists of a vault of hollow bricks, the springings of which rest upon small iron beams and the intrados of which is covered with plaster in order to form a flat ceiling.

A system devised several years ago by Messrs. Dennett & Ingle, of Nottingham, has been adopted in the construction of a certain number of public edifices in England. It consists (Fig. 32) of a beton vault

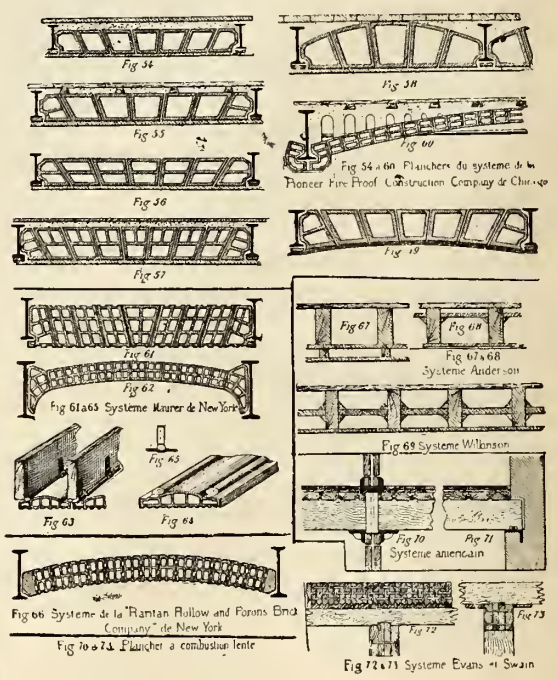


Fig 54
Fig 58
Fig 53
Fig 60
Fig 54 a 60. Planchers du systeme de la Pioneer Fire Proof Construction Company de Chicago
Fig 56
Fig 59
Fig 57
Fig 61
Fig 62
Fig 61 a 65 Systeme Maurer de New York
Fig 63
Fig 64
Fig 65
Fig 66 Systeme de la "Raritan Hollow and Forons Brick Company" de New York
Fig 70 a 74 Plancher a combustion lente
Fig 67
Fig 68
Fig 67 a 68 Systeme Anderson
Fig 69 Systeme Wilkinson
Fig 70
Fig 71
Systeme americain
Fig 72
Fig 73
Fig 72 a 73 Systeme Evans et Swain

EXAMPLES OF FIREPROOF FLOORS.

having for its base gypsum mixed with pounded bricks, chippings of stone, etc. This beton is spread upon centerings, and the haunches of the vault are filled up to the level of the floor, or else they are left empty. Fig. 33 shows a section of the ceiling of the council hall of the new Foreign Office. The cupola is 36 feet in diameter and 9 inches in thickness at the pendentives. Fig. 34 shows a section of the cupola situated over a tiring-room of Her Majesty's Theater, of London. It has the following dimensions: 30×20×5 feet. Numerous experiments have been made with these floors and they have given good results. Figs. 35 to 46 show a series of hollow brick floors of a special model. What precedes renders it unnecessary to give a detailed description of them. It will suffice to say that the inventor of the floor represented in Figs. 40 and 41 directs attention to his system in calling it the joist vault, allowing the light to pass.

Messrs. Doulton & Co., of Lambeth, have proposed a system of flooring (Fig. 47) in which hollow summers encircle the girder or floor timbers, the voussoirs consisting of hollow bricks one of the sides of which presents the same angle as the summers. These bricks are of special fire-clay. In addition to the joints between the bricks, smaller tail grooves are formed into which the cement can enter. The lower surface of the platband is likewise provided with the same kind of grooves into which enters the plaster forming the ceiling.

With the systems represented in Figs. 48 to 53 we have finished with the floors devised in Europe, and shall now pass to those invented in America.

*American Floors.*—In the construction of floors the Pioneer Fireproof Construction Company, of Chicago, employs a system of flat vaults of hollow bricks (Figs. 54 to 60). The section of the bricks depends upon the thickness of the floor, which, in turn, depends upon the length of the span. In each case, the bottom of the joint is prolonged by a longitudinal tile formed of the same material as the bricks. Fig. 60 shows some bricks designed for a vault of 60 feet span. The tympans are filled with beton with hollows at a few points to render the vault lighter. The thrust of the vault necessitates cross braces here and there, and, as the latter are placed under the intrados, they would, if they were not protected, constitute a source of danger during a fire. Iron cross braces ¾ inch in diameter are

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Fig. 1. Système Woodhouse et Potts

Fig. 2. Système Scott

Fig. 3 et 4. Système de Sir W. Fairbairn

Fig. 3.

Fig. 4.

Fig. 7 et 8. Briques creuses employées par Sir W. Fairbairn.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 9 et 10. Voûtes en briques creuses dites "Arch Pot"

Fig. 5 et 6. Système Moreland

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 13 et 14. Plancher de la Bourse du Commerce de Liverpool

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 16 à 18. Système Dawnay.

Fig. 11 et 12. Système Fox et Barrett

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15. Système Whichcord.

Fig. 27.

Fig. 28.

Fig. 27 et 28. Système W. H. Lindsay.

Fig. 19

Fig. 20.

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 19 à 22. Modification par Phillips du système Fox et Barrett.

Fig. 21.

Fig. 22.

Fig. 26.

Fig. 23 à 26. Système Homan Rodgers.

Fig. 33. Système Dennett et Ingle.

Coupe par le Dôme de la salle du Conseil de Cabinet du nouveau Foreign Office de Londres

Fig. 31. Système Vaux.

Fig. 34. Système Dennett et Ingle.

Fig. 32. Schema du système Dennett et Ingle.

Coupe par le Dôme du Vestiaire des Dames du Her Majesty's Theatre de Londres.

Fig. 29.

Fig. 30.

Fig. 29 et 30. Système Moreland

Fig. 35.

Fig. 42. Système Hornblower

Fig. 47. Système Doulton-Peto.

Fig. 48. Système Blanchard

Fig. 36.

Fig. 37

Fig. 49 et 50. Système Lindsay

Fig. 43.

Fig. 44.

Fig. 52.

Fig. 38

Fig. 39.

Fig. 35 à 39. Système Bunnett

Fig. 49.

Fig. 50.

Fig. 45.

Fig. 46.

Fig. 53.

Fig. 40.

Fig. 41.

Fig. 40 et 41. Système Hyatt

Fig. 43 à 46. Système Northcroft.

Fig. 51. Système Lindsay et Cie.

Fig. 52 et 53. Système Fawcett.

## EXAMPLES OF FIREPROOF FLOORING.

likewise placed in the system of flat vaults, and are bolted to one of the small beams at distances of from 8 to 10 feet.

Messrs. Maurer & Company, of New York, are constructing a system of fireproof floors (Figs. 61 to 65) with well baked clay firebricks. These bricks are embedded in cement, and are provided with dovetail grooves into which the cement and plaster of the ceiling can be introduced. The small beams and the joists are in each case protected by refractory materials.

The Raritan Hollow and Porous Brick Company, of New York, has got up fireproof floors formed of hollow brick vaults. The bricks are of well baked fire clay and the metallic part is protected by summers that rest upon small beams. Longitudinal grooves are moulded in the faces of the bricks in order to permit of the introduction of the cement and plaster of the ceiling.

We shall now pass to another sort of fireproof structures, and shall occupy ourselves in the first place with the application of silicated cotton or mineral wool. Figs. 67 and 68 show the manner in which this is employed by Messrs. D. Anderson & Son. In the first floor are fixed silicated flags under small iron beams by means of ashlering to which the ceiling of wood and plaster has been fixed. In the second arrangement, cleats are nailed to the joists that support the floor. Upon these cleats rest boards above which may be placed the mineral wool in a crude state or compressed in the form of flags. In the case shown in Fig. 69, a special plaster is used. This system is due to Mr. Wilkinson.

In the United States what is called the slow combustion system of flooring is often used. In this sort of construction, the external walls are of brick masonry. The floor and the roof are constructed of wood of wide section, and the floor timbers are supported by wooden columns. Figs. 70 and 71 show the principal forms of this sort of construction. A different system, from which cast iron is excluded, is due to Messrs. Evans & Swain (Figs. 72 and 73). This type of floor is employed at the East and West India Docks, of London, and in Westminster Hall, etc.—*Le Genie Civil.*

THE JINRIKSHA OF JAPAN.

## THE JINRIKSHA AT HOME.

THE jinriksha is the national carriage of Japan, and a most suitable and comfortable method of locomotion in such a climate, where there are so many interesting places beyond the access of railways, and where narrow streets, lanes, and field paths are so numerous. The vehicle in question is drawn generally by a single runner. It is truly astonishing how one pair of human legs and arms can so effectually do duty for a horse, and with what activity these Jehus trot and bound along with conveyance and passenger. The runners, called in Japanese "kuruma-ya," are small, light men, active, fleet, and particularly well adapted to their calling, while the mild climate makes it less of a drudgery than would be the case under ruder skies. These *hommes-chevaux* will easily cover from forty to fifty English miles a day, stopping at intervals for food and rest at one of the tea houses passed on their journey. Jinrikshas can easily be obtained in all the towns and villages of Japan, while in larger centers they literally swarm like cabs in London. Tourists and travelers often prefer this shaft carriage to the railway for short distances, as it enables them to see more of the people and the country in the districts through which they are passing. Provided with oil paper, a mackintosh, an umbrella, a sun hat or helmet, a little tinned food, a brandy flask, putting up at night at a native tea house where rice, fish, eggs, and frequently foreign beer, can be obtained, one can accomplish journeys of great length, even of several days' duration, without much inconvenience.

Jinrikshas—the word means man-power carriage—are said to have been invented in 1870 by a Japanese, Aluka Daisuke, of Tokyo; while another report credits a Mr. Goble, an American lay missionary, with having originated this vehicle three years earlier. There are at present said to be over 40,000 in the capital alone. The jinriksha has been introduced into Shanghai, Hong-Kong, Tong-King, and Singapore, where it is a great success and much appreciated.—*Daily Graphic, London.*

## CELLAR OR NO CELLAR?

By EDWARD ATKINSON.

IN conversation many years ago with the late Dr. Agnew, of New York, of highest authority on hygiene, he told me that he thought that, for sanitary reasons, there should be no cellar under any dwelling house. If there were, he remarked, the floor above should be most caretully sealed against the passage of any cellar air into the house, while the entrance to the cellar should be wholly outside the house. This was in the beginning of my practice in dealing with the construction of factories, and it became one of the motives, aside from safety and economy, in treating the subject of the basement floor.

I now venture to put a question which has become of considerable practical importance to architects; Ought there to be a cellar, in the ordinary sense in which that word is used, under the occupied parts of buildings of any kind, such as school houses in which children are taught, factories in which men and women work, lower stories or basements of houses where much of the household work is done? In other words, ought not the lower story of almost every building to be put on well drained ground above grade, both with a view to economy in construction and for sanitary reasons, if for no other?

In factory practice all types of basement floors built of timber and plank placed a few feet above the ground, in an excavation or even at grade when not open to the air on every side, with the expectation of ventilation beneath, have failed. It may be alleged that it has proved to be impracticable to ventilate a mere air space under a basement floor of a large building over the ordinary gravel or hard pan of the soil, so as to prevent the decay of timber. In the best mill practice excavated basements or cellars, half to two thirds under ground, with cemented floors of concrete, have been sufficiently well ventilated; but the type of construction makes an expensive underground story, of which, as a rule, but a small part can be put to effective use. It is apt to cost as much or even more by the square foot of floor than any other floor surface in the factory.

On the other hand, in many workshops and in some factories it is very desirable to be able to set machinery as nearly as possible upon the solid ground with timber and plank interposed between the ground and the machine, since, for many reasons, machinery may not be placed directly on concrete. This has been safely accomplished by making the concrete over a well drained floor space with asphaltum or coal tar in place of cement. Timber and plank laid in cement will rot very speedily, and a cement concrete is a quick conductor of heat. An asphaltum or coal tar concrete properly laid is a non-conductor of heat, an antiseptic, and is impervious to moisture; upon such a surface timber and plank laid solid last as well as in any other part of a factory building.

Under these conditions, the question arises, May not expensive basements or cellar stories be done away with, except so far as it is either cheaper or more convenient to make an excavation for absolute use and not merely for the purpose of interposing a partly underground story beneath the main floor of a building?

In dealing with the condensation of moisture on interior surfaces, absolute success has been attained in preventing such condensation even over the Fourdrinier or the cylinder machines in paper mills, from which the maximum quantity of humidity is discharged in the process of converting wet pulp into dry and finished paper. Composite roofs made of proper materials six to seven inches thick have proved to be absolute non-conductors of heat, cold and moisture, and in their application to these machine rooms, with proper ventilation to remove the steam, the condensation of moisture on the under side has been wholly done away with.

Reverse this process: May we not put a composite floor underneath the lower story of a building, reversing the order of materials which are used in the roof, and in this way put an absolute non-conductor of heat and moisture between the first occupied room and the well-drained soil below this composite floor? Why not? Many examples can be cited of complete success in this practice, which is now becoming common in our lines.

The following conversation occurred between myself and a very practical man not long since, in the discussion of a building in which he desired to put all his main work on a single floor. On my suggesting this method of construction, he said, "Oh, but I must have a cellar! It would not be fit to build such a building without a cellar."

"Very well," I replied, "then we will put a cellar under your main floor. You will desire to floor your cellar, will you not?"

"Certainly"

"What will you floor it with?"

"Cement or concrete."

"Would it not be better to use coal tar or asphaltum?" explaining the reason.

"Certainly," said he, "we will adopt that floor."

"Then," said I, "you had better have a light cellar, had you not? You can afford to put your main floor considerably above grade for your purpose."

"Oh, yes; light by all means!"

"Shall we put it half way out of the ground?"

"Yes; as much as that."

"Good!" said I. Next I asked, "But where you propose to put this building will it not cost you a great deal more to excavate than it would to keep up well toward the surface?"

"Yes," he replied; "very hard place to dig."

"Then," said I, "suppose we put the cellar two thirds above ground."

"Well," he replied, "why not?"

"Now, then," I said, "you have just back of your location a good gravel bank; wouldn't it be a good deal less costly to grade up a foot and drain well than it would be to dig any hole of any kind?"

"Why, certainly," said he.

"Then," said I, "why not put your cellar floor one foot above grade and drain it well?"

"Why," said he, "what has become of my cellar?"

My reply was, "You have put it in the best place possible. With the floor one foot above ground, and that cellar wholly above ground, being placed under your main floor, will cost you less than it would to dig a great hole in the ground in which you will generate foul air and accumulate rubbish."

"But," said he, "you have given me a two-story building with two floors, and that is double the floor space that I want."

"Yes," I replied, "I have given you a two-story building with two equally useful floors at less cost than you would have put into a one-story building with a deep and almost useless cellar under it. What are you going to do about it? Will you waste your money by digging a hole in the ground?

"No," he said.

"Well, what will you do?"

"Why," said he—"why can't I leave out the upper story and bring the roof down so as to cover in the first story?"

"Well," I remarked, "why not? I think you have landed where I meant you should. If you can cut off the passage of heat, cold, and moisture by properly constructing a composite floor directly upon well-drained ground, why do you want to dig a hole underneath it, at heavy cost?"

"But," said he, "I meant to store my coal in the cellar."

"Well," I said, "you can dig a hole for your coal if you want to; put it down in the hole in order to go through the work of bringing it up again. Why not put it in a shed in the rear on the level of the floor where you use it?"

"But," said he, "I meant to have put my sanitary appliances down below."

"Then," said I, "you would probably have made your cellar a great deal more foul than it would be under ordinary conditions. Better put them outside, for every reason, whether you have a cellar or not."

My practical man thought he had found for himself an excellent method of getting the room he needed on one floor at about three fifths or perhaps one half of what he expected it would cost him on his own plan for one floor and cellar. Yet there are still many persons who think that they must have a cellar under the main floor.

To what extent can such persons be persuaded to build their cellars wholly above grade by at least one foot?

In other words, the question put to architects and, through them, to owners, may well be, if you have no use for a cellar, why put one under your building? A building costs a certain sum by the unit of the square foot of floor, counting every floor. If the use of only one floor is called for, why put a more expensive floor ten feet below it by digging a hole in the ground?

If it is expedient to use two floors and to have all the light, air and ventilation one can get on both, why make one a basement partly below ground and partly above? Why not put them both above grade?

Of course these questions apply to open spaces where it is not necessary to go down deep into the bowels of the damp earth or high up into the air in order to get floor space. On a broad area floor space on one floor can be provided at less cost than by excavating or going high into the air; on two floors at the lowest cost at which floor space can be provided in any way.

Then why provide either cellar or basement floors below grade except in deference to a superstition derived from a period when the right way of constructing a floor directly upon the ground had not been devised?—*American Architect.*

SPIDERS are not always solitary and selfish, as some naturalists have asserted. Dr. McCook, an authority on the subject, has told the British Association that "there really are cases in which the male and female spiders live in amicable relations for a considerable period."

## REPORT OF THE MICROSCOPIST OF THE DEPARTMENT OF AGRICULTURE.

THE last report of Dr. Thomas Taylor, microscopist to the Department of Agriculture, contains much valuable information relating to edible and poisonous mushrooms. This is illustrated with elegant plates in colors.

Edible mushrooms, he tells us, are usually characterized by an odor like that of fresh meal, and a flavor of hazel nuts; non-edible varieties have sometimes an unpleasant odor, and produce a biting, burning sensation on the tongue and throat, even in very small quantities, but several of the *Amanitas* have only a slight odor and taste, and certain species of mushrooms, acrid otherwise, become edible when cooked.

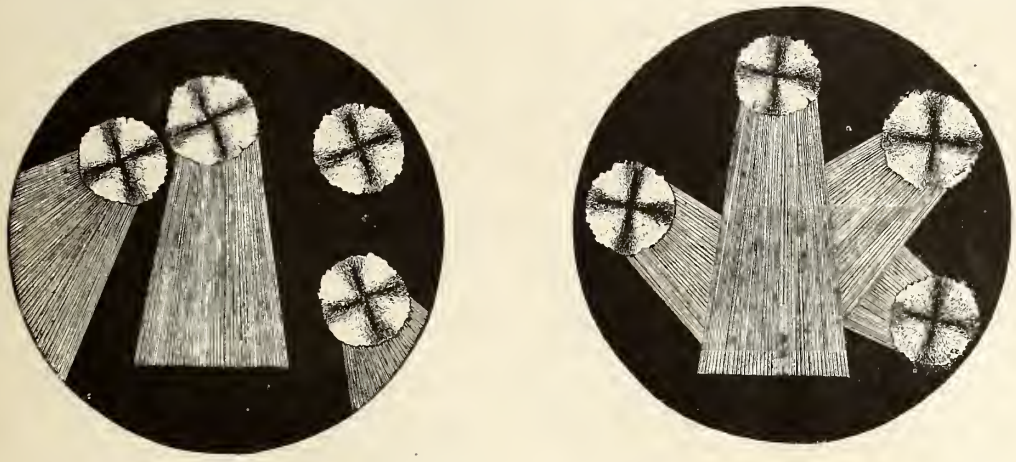
Mushrooms of vivid colors and viscid caps are not always poisonous. It is by some supposed that high colors and viscidity are indications of non-edible species, but there are numerous exceptions here. *Russula alutacea*—the pileus of which is a purplish red—*Amanita Cæsarea*, and other species of brilliant coloring are known to be edible. As to viscidity, two very viscid species, when young, are among the highly prized esculents by those who know them, viz., *Fistulina hepatica*, or the ox tongue, and *Hygrophorus eburneus*, the ivory mushroom.

*Crystallization of Oils or their Acids.*—Dr. Taylor describes his freezing box, a new device prepared for use with the microscope. It is the result of a long experienced want of some method of crystallizing the various oils and their acids so as to obtain micro-photographic views of their respective crystalline arrangement, a knowledge of which is important in microscopic investigations relating to the adulterations of foods and other oils. Another advantage offered by this invention is that by this method objects in natural history mounted in varnish or other media may be thrown on a screen and photographed. In the use of sunlight or Drummond light, the liquid soon reaches 212° F., and thus renders useless a valuable mount.

The freezing liquid may be used repeatedly or until it ceases to be cold enough for the purpose. Any of the usual freezing liquids or ammonia gas or ether may be used. The tube which carries off the liquid from the freezing box should terminate in a small orifice to prevent unnecessary waste.

The box is provided with an air escape to facilitate the operation of filling the box with the freezing liquid. When this is accomplished, plug the opening and secure the box in position. In using ether, remove the plug to allow the ether to escape, or insert a tube to convey it into a separate vessel, where it may be condensed.

The solid fat of the chaulmugra oil is easily separated from the oil by freezing. The fat thus procured may be mounted in the usual manner. It should then be heated sufficiently to make it liquid and placed quickly under the microscope. As it cools, crystallization rapidly progresses. At first globular masses will be observed, each one showing, under polarized light, a well-defined cross. No sooner does one of these globular masses form than a second crystallization takes place, proceeding from the globular accretion in the form of an elongated, spreading fan.



CHAULMUGRA FAT CRYSTALS.

Figs. 1 and 2 represent the crystalline iforms of the solid natural fat of the oil of chaulmugra procured by the freezing process. The very peculiar forms which this fat assumes in crystallizing leads me to the belief that it is a new and undescribed fat.

## A NEW SULPHIDE OF CARBON.

By A. E. TUTTON.

A NEW liquid sulphide of carbon of the composition $C_3S_2$ has been isolated in a somewhat remarkable manner in the chemical laboratory of the University of Buda-Pesth, by Prof. Von Lengyel, who contributes an account of it to the current *Berichte*. In addition to the well-known disulphide of carbon, several other substances supposed to be compounds of carbon and sulphur have from time to time been described; but as they appear to have been amorphous insoluble solids very difficult to purify, there is very little evidence of their being definite compounds. The substance now described, however, appears to be a very well characterized liquid compound of unmistakable odor and corrosive action upon the skin, and capable of being distilled under diminished pressure.

The method of preparing it was accidentally discovered during the elaboration of a number of lecture experiments illustrating the synthesis and decomposition of carbon disulphide. It was long ago pointed out by Berthelot that this familiar substance decomposes at a temperature but slightly higher than that at which its formation from its constituents occurs. Buff and Von Hofmann subsequently showed that the temperature of a glowing platinum wire was ample to bring about slow dissociation of the vapor, and that the disruption of the compound occurred very rapidly indeed at the temperature of red hot iron wire. An experiment was therefore arranged to ascertain whether rapid removal of the vapor of the synthesized compound from the heated sphere of action would largely prevent the loss by dissociation, and in order that the test should be a severe one, the rapidly moving vapor was subjected in its passage to the high temperature of the electric arc. It was during this experiment that the new sulphide of carbon was unexpectedly produced.

A little more than a hundred cubic centimeters of carbon disulphide were placed in a flask arranged over a water bath. A large globe had been previously sealed onto the neck of the flask, through tubuli, in which the carbon electrodes were inserted. To a third tubulus of the globe an upward condenser was fitted, the interior tube of which was finally bent downward to serve as a gas delivery tube. The water bath was then heated and the carbon disulphide maintained in rapid ebullition, the electrodes were approached until the powerful current from accumulators was transmitted, and then withdrawn so as to generate the arc. The electric arc in carbon disulphide vapor under these conditions is a remarkable phenomenon; it is seamed with a dark band passing along its center from pole to pole, and the brightest spots of the incandescent terminals are just where the band appears to touch them.

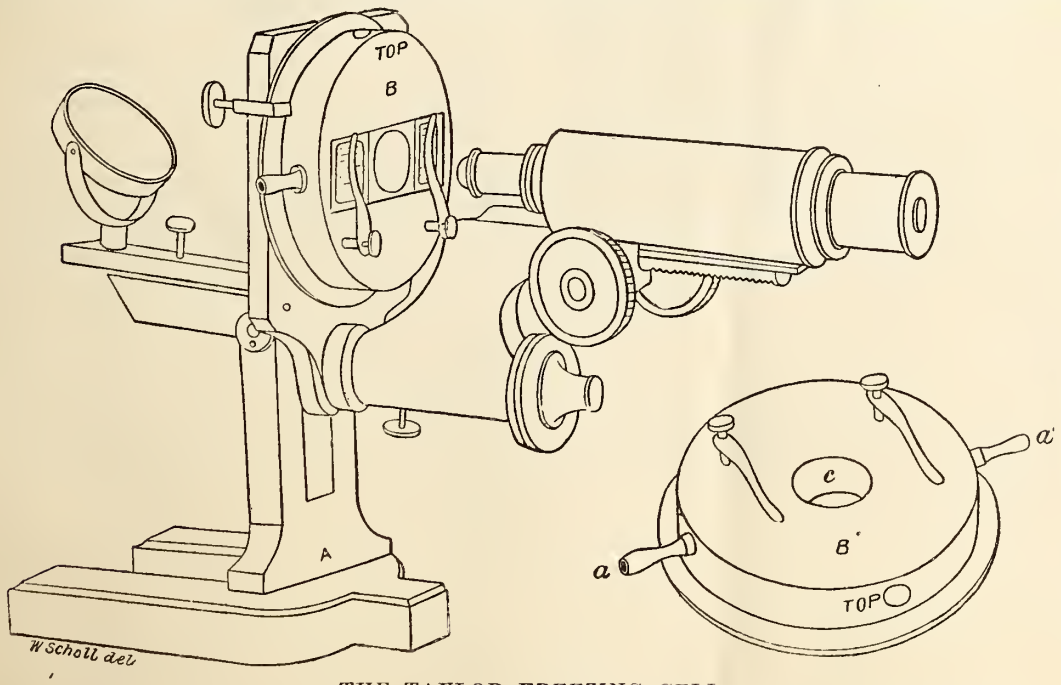
The carbon disulphide was kept boiling and the arc passing for a couple of hours, during which the globe was filled with the vapor, which condensed in the condenser and fell back into the flask. The interior of the apparatus soon commenced to blacken with liberated carbon, which collected upon the surface of the liquid, and an extraordinary strong tear-exciting odor soon made itself evident in the neighborhood of the apparatus. At the conclusion of the experiment the residual liquid was cherry red in color, and was transferred to a closed vessel containing copper turnings, in order to remove the free sulphur present. After being thus left for a week it was filtered, and the carbon disulphide evaporated at a low temperature in a current of dried air, in order, if possible, to isolate the substance endowed with the powerful odor. Eventually a few cubic centimeters of a deep red liquid, the new sulphide of carbon, were left, which possessed the odor in greater intensity, a trace of the vapor producing a copious flow of tears, accompanied by violent and persistent catarrh of the eyes and mucous membrane. A drop of the liquid, moreover, at once blackened the skin.

The specific gravity of this liquid is 1·2739, so that it sinks under water, with which it does not mix. When heated it polymerizes into a hard black substance. If the rise of temperature is gradual the change occurs quietly, but when rapidly heated to 100–120° the polymerization takes place with explosive force, the interior of the vessel being covered with projected deposits of the black substance. Analyses, both of the liquid and of the black solid, indicate the same empirical formula, $C_3S_2$, and molecular weight determinations of the liquid, dissolved in benzene, by Raoult's method, agree closely with the molecular weight corresponding to that formula. The liquid can be partially distilled at 60° *in vacuo*, a small portion, however, always polymerizing. The liquid, moreover, spontaneously changes in a few weeks into the more stable black solid modification. The solutions of the liquid in organic solvents likewise slowly deposit the black form.

The liquid readily ignites, burning with a luminous flame and forming dioxides of carbon and sulphur. Caustic alkalies dissolve it, forming dark-colored solutions, from which dilute acids precipitate the polymerized back compound. With alcoholic potash the action is very violent. A drop of concentrated sulphuric acid causes instant passage to the black form accompanied by a hissing noise. Nitric acid provokes an explosion and ignition; but 70 per cent. acid dissolves it completely and quietly.

The black polymeric modification is readily soluble in caustic alkalies, but acids reprecipitate it unchanged. When heated it undergoes a remarkable change, sulphur subliming, and a gas, inflammable and containing sulphur, but not carbon disulphide, is liberated, the nature of which is reserved for a further communication.

The liquid sulphide combines readily with six atoms of bromine, with evolution of heat. The substance is readily isolated when bromine is dropped into a solution of $C_3S_2$ in chloroform, as it is insoluble in that solvent. Strangely enough, this compound, $C_3S_2Br_6$, is endowed with a pleasant aromatic odor, two substances of frightful odors thus uniting to form an agreeably odoriferous compound, a striking example of the effect of chemical combination.—*Nature.*




THE TAYLOR FREEZING CELL.

A represents a microscope; B, the freezing box; made of brass or of German silver, and attached to the substage of the microscope by means of two clamps, one on either side of the box. B is a separate view of the apparatus: $a$ and $a^1$ represent tubes, one of which supplies a freezing liquid, the other carries it off; a pail to receive the waste liquid is in readiness, and is connected in the usual way by means of rubber tubing: $c$, an opening through the center of the box, which admits of the transmission of rays of light to the object under investigation.

## NITROGEN AS FOOD FOR ANIMALS AND PLANTS.

By VAUGHAN CORNISH, M.Sc., F.C.S.

"THE atmospheric fluid, or common air," Lavoisier wrote, "is composed of two gases or aeriform fluids, one of which is capable, by respiration, of supporting animal life, and in it metals are calcinable and combustible bodies may burn; the other, on the contrary, is endowed with directly opposite qualities—it cannot be breathed by animals, neither will it admit of the combustion of inflammable bodies, nor of the calcination of metals.

"We have given to the base of the former, which is the respirable portion of atmospheric air, the name of oxygen. . . . The chemical properties of the noxious portion of atmospheric air being hitherto but little known, we have been satisfied to derive the name of its base from its known qualities of killing such animals as are forced to breathe it, giving it the name of *azot*, from the Greek privative particle $\alpha$ and $\zeta\omega\eta$, *vita;* hence the name of the noxious part of atmospheric air is *azotic gas.*"

Lavoisier, who was the first clearly to state the chemical nature of air as composed of two substances, one chemically active and the other chemically inert, occupied himself for many years in developing the knowledge of the chemistry of oxygen—the active constituent of air. The readiness with which oxygen gas can be made to act upon and combine with other substances enables its chemical functions to be determined with comparative ease, and the mode in which this element is used in the nourishment of the animal body was soon elucidated with tolerable completeness; on the other hand, the inertness of *azot* (or nitrogen, as the substance soon came to be called in England) rendered the chemical study of this constituent of the atmosphere a less attractive as well as a slower and more laborious pursuit. Thus, if we compare the ways in which the oxygen and nitrogen of the air are taken hold of to build up the animal body, we find that one process is direct and in its main features simple, whereas the processes by which the nitrogen of the air becomes a constituent of the flesh and muscle are, on the contrary, indirect and complicated. Even at the present time, a hundred years after the researches of Lavoisier, the mode of "assimilation of nitrogen" is only beginning to be understood. When air enters the hollow cells of the lungs, the blood, flowing round the cells in little veins and capillaries, seizes upon and "fixes" the oxygen, which freely passes through the thin walls of the air cells, and carries to every part of the body the combined oxygen which it has thus seized upon. Parting in its passage through the body with the oxygen which it has seized

from the air, the blood acts as carrier of oxygen from the air to the muscle, flesh, nerve, and other parts of the body. But the blood has no power to seize upon and fix the nitrogen gas which enters the lungs at every breath. The blood has to obtain its nitrogen from the animal and plant food which is taken into the stomach; the throat and not the windpipe is the channel by which the nitrogen of the air is supplied to the body. Animals used by man for food obtain their nitrogen from plants. Plants have to depend ultimately upon the air for their supply of nitrogen.

The plant, however, does not appear to be able to assimilate the free atmospheric nitrogen through its leaves any more than an animal can assimilate the gas through its lungs. Leaves catch the carbonic acid of the air as the lungs of animals catch the oxygen of the air; but the nitrogen, it seems, has to reach the sap through the roots—it has to be fixed in some way—before the plant can feed upon it. Recent researches seem to have proved that on leguminous or pod-bearing plants there lives a class of bacteria which have the power of feeding directly upon the free nitrogen of the air. They "fix" the nitrogen, which afterward becomes available for plant food. Perhaps this only happens after the death of the bacteria, when their substance has undergone decomposition and the nitrogen compounds have been converted into a soluble form, so that they can enter the sap in the same way as the rest of the food derived by plants from the soil.

The soluble form in which it appears that nitrogen is mostly taken up by the roots of plants is known as the nitrate "form" or state of combination, in which nitrogen is combined with oxygen as it is in niter and in nitric acid. Besides bacteria associated with leguminous and possibly other orders of plants, there is another agency which brings the nitrogen gas of the atmosphere into combination with oxygen; this agent is electricity. Electric discharges in the atmosphere cause the combination of relatively small quantities of nitrogen, and the soluble oxides of nitrogen thus formed are carried down in solution by the rain, thus adding to the quantities of nitrates in the soil. As far as it is at present known, these two agencies, electricity and bacterial life, are the only carriers of nitrogen from the air to the soil.

Most of the nitrogen at any moment present in the world's soil is, however, derived from the substance of the preceding generations of plants. The nitrogen required to be supplied to the world's soil for the crop of any one year is only the difference between what is abstracted from the soil by the plant crop and what is restored to the soil by the death and decay in the vegetable and the animal kingdom.

The difference between the two amounts may be relatively small for the whole of the earth's surface, and might perhaps be *nil* if large quantities of nitrogen as nitrate were not being constantly carried into the sea by rivers.

The nitrogen in vegetable and animal substances is combined with carbon, and nitrogen in this state of combination may be termed *organic nitrogen*. Nitrogen when in this form is not directly available as a food for plants. By the process termed decay in the case of plants, and putrefaction or decomposition in the case of animals, the nitrogen is set free from its combination with carbon, and ammonia or a compound of ammonia is produced. In ammonia, nitrogen is in combination with hydrogen; and nitrogen, in this state of combination, we will call *ammoniacal nitrogen*. Free ammonia gas, formed in the decomposition of materials containing organic nitrogen, is ultimately brought into the soil in a state of solution by means of rain or dew, owing to the fact that ammonia gas is extremely soluble in water. Much of the ammonia produced by the decomposition of organic matter meets at once either with water or with some material with which it can combine, and thus from the first is retained in the soil. Plants are able to feed directly upon ammoniacal nitrogen; but in the greater part of the nitrogenous food of plants the nitrogen is in combination with oxygen, *i. e.*, in what we have termed the "nitrate" condition. The decomposition of the organic matter of the soil (which is commonly called *humus*) is effected through the agency of the *nitrifying bacteria*. They first split up the organic matter into water, carbonic acid, and ammonia, and then further assist the oxidation of ammonia to nitric acid. The conditions favorable to nitrification are that the oxygen of the air should have free access, that the soil should be sufficiently moist, but not water-logged, and that the temperature should be fairly high. In the presence of an alkali or alkaline earth in the soil, the nitric acid forms a salt (termed a nitrate). Where lime or carbonate of lime is present, soluble calcium nitrate is produced, and in this form plants obtain much of their nitrogen. Where potash is present, niter or saltpeter is formed, as, *e. g.*, in dry districts of India, where niter is found as an efflorescence on the surface of the soil. Chile niter, or Chile saltpeter, is the nitrate of sodium, and occurs in large deposits in the rainless districts west of the Andes, in Chile and Peru. In a wet climate such deposits would be speedily washed away, and carried into the rivers and the sea. We have referred before to the loss of the nitrogen which the soil of continents undergoes on account of soluble nitrates finding their way into the sea. The great quantities of nitrates from Chile and Peru which have of late years been applied to the fertilization of the land are a contribution won back from the ocean; the nitrates of the nitrate beds have been formed by the oxidation of guano, the *dejecta* of fish-feeding sea birds. Recently "artificial guano" has been manufactured to a considerable extent from the carcasses of coarse fish, caught for the purpose by fishing from ships specially employed in connection with this manufacture.

Where crops are cut and carried from the place where they are grown, it is necessary to provide for the restoration to the soil of certain materials, particularly nitrogen, which are thus removed instead of being allowed to return to the soil through the death and decay of the plants, as would be the case in a state of nature. This is partially effected by returning to the soil the manure from the animals of the farm which fed upon the crops. When the beasts themselves, however, are sent into the towns, they carry away large quantities of the particularly valuable constituents of a fertile soil, such as nitrogen and phosphorus. In a more primitive condition of agriculture, the beasts would be eaten on the farm itself, and the greater part of the nitrogen, etc., would find its way back to the soil whence it came. Facilities for communication and transport, however, and the concentration of the population in towns all tend to make farming, more particularly manuring or soil feeding, a more complicated matter. This is especially the case where nitrogenous stuff, *e. g.*, hay, is sold off the farm, instead of being consumed upon it, and oil cake or other artificial feeding stuff is purchased in its place. The oil cakes are rich in fat as well as in nitrogen, but the albuminoid ratio is always high, in some cake as high as 5:7. The method of calculating the nutrient or albuminoid ratio was explained in a former article (*vide Knowledge*, July, 1893). Account has to be taken of this ratio in deciding upon combinations of artificial foods for the use of stock, just as the authorities of prisons, etc., have to consider the nutrient ratio of the diet they supply. Young growing animals retain a larger proportion of the nitrogen supplied to them than the full grown beasts which are being fatted. In the former case much of the nitrogen goes to build up the muscular flesh, and the manure given by young growing animals is proportionately poorer in nitrogen. On the other hand, full grown animals which are being fatted for market store up chiefly fatty tissue, which contains no nitrogen, and consequently these animals return a larger proportion of nitrogen to the ground. In feeding different species of animals account has to be taken not only of the albuminoid ratio but of what is called the *digestion coefficient*, or proportion which the food stuff taken bears to the amount digested.

This proportion is different in the case of different species of animals. In the case of ruminants a large proportion of indigestible fiber in the food is actually necessary. Sheep cannot assimilate more than half of the 12 per cent. of nitrogenous matter contained in clover hay. Human beings would be able to assimilate scarcely any of the nutriment in hay, the White King, in "Through the Looking Glass," who took hay when he was faint, being of course an exception to the rule. By submitting the hay to preliminary treatment by an ox or sheep, man is able to assimilate the nitrogen and other nutrients contained in hay in the form of beef or mutton.

To sum up, we may say that nitrogen exists as

1. *Atmospheric nitrogen*, in which *the atoms of nitrogen are combined with each other*. The bacteria associated with leguminous plants feed upon atmospheric nitrogen.

2. *Ammoniacal nitrogen*, on which plants can, and to some extent do, feed. *Here nitrogen is combined with hydrogen.* The source of ammoniacal nitrogen is the decay of animals and plants.

3. *Nitrate nitrogen*, in which *nitrogen is combined with oxygen.* This is the principal form in which plants obtain their nitrogen. Nitrates, generally speaking, are formed by the oxidation of the ammoniacal compounds produced in the decay of animal and vegetable matter. In the presence of alkalies in the soil, such as lime and potash, soluble nitrates are formed which supply both nitrogen and alkali to plants. Nitrate nitrogen is also brought into the soil by the action of electrical discharges in the atmosphere.

4. *Organic nitrogen*, in which the *nitrogen is combined with carbon.* This is the form in which nitrogen is taken by animals, either directly from vegetable food—more particularly from green vegetables—or in flesh-feeding animals, partly as above and partly in the form of lean meat. The organic compounds of nitrogen after the death of the animal or plant furnish the food of the *nitrifying bacteria*, which assist in the work of splitting up these compounds, sending off the carbon as carbonic acid, and leaving the nitrogen, first in combination with hydrogen, and afterward oxidizing the nitrogen to the form of a nitrate.—*Knowledge.*

## TESTS FOR COCOANUT AND PALM OIL.

THE following scheme to detect the adulteration of these oils with others may be used:

First operation.—28 c. c. of the sample are shaken for one minute in a graduated tube with 40 c. c. of alcohol of 90°, when the oil, deprived of its free fatty acids, sinks to the bottom. Alcohol of 85° then absorbs a certain quantity of neutral fatty matters, and the oil dissolves 15 to 20 per cent. of alcohol. The solvent power of the oil diminishes sensibly in the presence of insoluble oils, while that of the alcohol increases in the presence of oils soluble in alcohol of 95°, castor oil, resin oil, etc., which latter can be readily characterized by their physical and chemical properties.

Second operation.—5 c. c. of cocoanut oil, previously washed with alcohol of 95°, are treated in a graduated tube with 10 c. c. of absolute alcohol, and the mixture placed on the water bath at 30° to 31° C.; it is now shaken for 40 seconds and replaced on the water bath. Pure cocoanut oil dissolves completely under these conditions, while contaminated with oils insoluble in alcohol, such as earth nut, sesame, cottonseed, and maize oils, it does not sensibly dissolve, but falls to the bottom of the tube. Cocoanut oil containing 20 per cent. of palm oil separates, but when the percentage is below this a turbid emulsion results. Palm oil is treated in the same manner, only with 20 c. c. instead of 10 c. c. of absolute alcohol. Five c. c. of palm oil containing 20 per cent. and upward of cocoanut oil is soluble in 15 c. c. of absolute alcohol, while under these circumstances the pure oil forms a turbid emulsion.

The purity of cocoanut and palm oil cakes is determined by extracting the fats and treating them in the manner above described.

The volatile fatty acids in butter fat may be estimated thus:

Five grammes of filtered dry butter fat is placed in a flask of 300 to 350 c. c. capacity, and 2 c. c. of 50 per cent. aqueous soda and 20 c. c. of glycerol added. The mixture is then carefully boiled over wire gauze, until all the water is expelled, the flask being gently rotated the while; the heating is then continued with a smaller flame; in 15 min. a clear soap solution is obtained, which after cooling is mixed with 90 c. c. of water and 50 c. c. of dilute sulphuric acid (50 c c. of acid per liter), some fragments of pumice added, and the mixture distilled until 110 c. c. has passed over. The author regards the method as quicker and more convenient than the older methods, but the test analysis appears to be far from satisfactory.

Baudouin's test for sesame oil in olive oil is applied as follows:

0·1 gramme of sugar is dissolved in a test tube in 10 c. c. HCl, sp. gr. 1·19; 20 c.c. of the sample of olive oil is then added, the whole thoroughly shaken for a minute, and allowed to settle.

If the oil is pure the acid and oils retain their original color, but if sesame oil is present, they are both of a decidedly reddish shade.

[Continued from SUPPLEMENT, No. 946, page 15126.]

## ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

*Lecture IV.*†

IT seems to me that much Japanese work presents singular analogies to that of the Italian Renaissance, and the second of the two works for which I have claimed special admiration is, fortunately, in our own collection in the South Kensington Museum. It is the wonderful incense holder, with peacocks and pigeons in ordinary colored bronze exquisitely modeled, and the casting must have been effected by the method of *cire perdue*. A brief description of the method of casting will be given subsequently. This incense holder is the work of Chokichi Kako, and it was exhibited in the Japanese section of the Paris exhibition of 1878. I hope it will be one of the next objects we shall be permitted to analyze, but I do not anticipate that it will differ much from characteristic Japanese bronzes, though it probably contains less lead than the bronze tortoise, of which analysis is given. Fifteen years have elapsed since then—a long period in the life of a Japanese; but the same artist is again represented at Chicago, this time with an even more important work. He has designed a series of twelve falcons, birds which have long been held in high esteem in Japan. The varieties of plumage have given the artist free scope for all manner of dexterous experiments with the various alloys and patinas, in the use of which the Japanese have no rivals. The birds have been produced by the *cire perdue* process, and colored by pickling. Upon one a tone of yellow and green gold has been arrived at; another is in a brown alloy; another, in black shakudo, glistens with wet; while yet another is of unpolished silver. Few birds present such delicate gradations in grays and browns; but these tints are admirably caught; while each bird is depicted in some characteristic attitude, which only lengthened study of the original has enabled the artist to convey.

Specimens of ancient bronze analyzed by E. J. Maumené‡ gave the following results:

| | I. | II. | III. | IV. |
|---|---|---|---|---|
| Copper | 86·38 | 80·91 | 88·70 | 92·07 |
| Tin | 1·94 | 7·55 | 2·58 | 1·04 |
| Antimony | 1·61 | 0·44 | 0·10 | — |
| Lead | 5·68 | 5·33 | 3·54 | — |
| Zinc | 3·36 | 3·08 | 3·71 | 2·65 |
| Iron | 0·67 | 1·43 | 1·07 | 3·64 |
| Manganese | — | trace | — | — |
| Silica | 0·10 | 0·16 | 0·09 | 0·04 |
| Sulphur | — | 0·31 | — | — |
| | 99·74 | 90·21 | 99·79 | 99·44 |

Mr. Alfred Gilbert, A.R.A., the excellence of whose mental castings is well known, considers that the following composition is very suitable for casting by the *cire perdue* methods:

| | |
|---|---|
| Copper | 91·40 |
| Tin | 5·70 |
| Lead | 2·90 |
| | 100·00 |

H. Morin§ has shown that the black patina of certain Oriental bronzes is due to the presence of lead, and MM. Christofle and Bouilliet‖ confirm this view, but state that the patinas may be produced of a wide range of tint on pure electrolytic copper by the use of suitable reagents, and although they provokingly refrain from "disclosing" what these reagents are, they say that the tint is due to two different molecular states of cuprous oxide.

Now doubtless the artificial patina is, to a considerable extent, more dependent on the nature of the pickling than on the composition of the copper alloy used, but it is nevertheless true that there are solutions which give a varied range of tints if the compositions of the copper be altered but a little.

It would, at first sight, appear to be useless in London to think of composing bronze so as to give a pure patina. Take, for instance, one of our last erected monuments—the equestrian statue of Lord Napier of Magdala, which is placed opposite the Guards Memorial in Waterloo Place. A few months ago the patina began to form, and iridescent tints played over his features, and unsightly rain stains ran down his horse; now the layer is thickening, and gray brown tint deepening, but there is no velvety brown of oxide, or green and blue of carbonate. The soldier, field glass in hand, is sternly looking away from the Athenæum and the learned societies, as if conscious that, in the present state of the London atmosphere, he was beyond the aid of science, for science has clearly stated that, so long as bituminous coal is burnt in open fireplaces, London must be smoky, and man and horse alike will soon be covered with the black pall of soot and sulphide of copper which now enshrouds the unfortunate occupants of adjoining pedestals, Franklin and Lord Clyde.

In Mr. Alfred Gilbert's monumental fountain, in memory of the late Lord Shaftesbury, which is placed at the Piccadilly end of Shaftsbury Avenue, an at-

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† Some of the particulars contained in this lecture were given in a lecture delivered at South Kensington Museum in 1892, and some portions, relating to Japanese art metal work, formed the subject of a paper read before the Applied Art Section of this Society, which appeared in the *Journal* June 30, 1890.

‡ "Comptes Rendus," lxxx., 1875, p. 1009.

§ "Comptes Rendus," vol. 78, 1874. 811.

‖ Ibid., 1019.

tempt has been made to enrich the composition by the sparing use of colored patina among the marvelously beautiful details of the work, the metal itself nearly approaching, I believe, gun metal in composition. A winged aluminum figure, moreover, surmounts the structure, and the effect of weather upon it will be watched with great interest. But can nothing be done to preserve our statues in the atmosphere of London? Much, I am satisfied, may be done. When the metal has once obtained a coating of patina, it should be carefully wiped, to remove extraneous deposits of soot. Look at the paws and flanks of the sphinxes which guard Cleopatra's Needle on the Embankment. In the evenings they form a center of attraction for the London children, and the more adventurous clamber over the beasts and slide down their haunches, the dark patina of which has become beautifully polished, although there does not appear to be any wear of the finer details of the modeling. When Trafalgar Square was more used as a meeting place than it is now, and when the base of Nelson's column served as a rostrum, the paws of the lion were beautiful in their lustrous polish over the dark patina; and in several London decorative works in bronze unexpected patches of polished patina are to be seen, which owe their luster to the fact that they form a convenient rest to some lounging *habitue* of the spot. The polish on the lions in Trafalgar Square, and on the sphinxes on the Embankment, afford the best indication of what might be done by careful wiping, and deserve attention as examples of the unconscious services to art which have been rendered by the agitator and the "arab."

I have finished with the bronzes for the present, and will turn to a singular group of alloys in which the copper and tin are subordinated to zinc itself, and these alloys are well illustrated by the Indian *bidri* wares.

The *bidri* objects, Nos. 36 to 39, are a peculiar series of alloys. They are chiefly zinc containing a quantity of copper and lead, with smaller amounts of tin and iron. The amount of lead in No. 37 is remarkably low, and, as it is very difficult to purify zinc from lead, it would appear that a very pure ore of zinc must have been used in the preparation of this metal. Apparently copper is the predominating metal associated with zinc in this *bidri* alloy. From this it is probable that No. 38, which contains none of it, is not Indian, but Hungarian, as the museum description suggests. In the other specimen, to which a doubtful origin is assigned (No. 39), copper is present, but in small proportion, tin being the secondary metal. This indicates that it is not Indian.

These works are beautifully damascened with silver in the form of thin plates, which are let in to undercut depressions in the surface of the metal of which the objects are made. It then takes a fine dark color by exposure and tarnish.

*No.* 36.—*Ewer*, with cover. Oxidized metal, damascened with silver. *Indian*, modern. H. 2 ft. 11 in., diam. 2 ft. 4 in. Given by her Majesty the Queen. 587.—'54.

*Analysis.*

| | |
|---|---|
| Lead | 1·298 |
| Copper | 3·510 |
| Iron | 0·049 |
| Silver | nil |
| Zinc, by diff | 95·143 |
| | 100·000 |

*No.* 38.—*Bottle*, with cover. Metal, with raised chasing of flower and leaf pattern, covered with gold and silver foil. *Hungarian* or *Indian*. Latter half of seventeenth century. H. 14⅜ in., diam. 5⅞ in.

*Analysis.*

| | |
|---|---|
| Lead | 0·956 |
| Tin | 0·346 |
| Iron | 0·084 |
| Copper | nil |
| | 1·386 |
| Zinc, by diff | 98·614 |

*No.* 38A.—*Vase*. Oxidized metal, damascened with silver. *Indian*, modern. H. 23 in., diam. 22 in. Given by her Majesty the Queen. 585.—'54.

*Analysis.*

| | |
|---|---|
| Lead | 1·437 |
| Tin | trace |
| Iron | 0·039 |
| Copper | 6·905 |
| | 8·381 |
| Zinc, by diff | 91·619 |

A singular case in which bronze, brass and a little gold are combined has already been described in a lecture delivered before this society, on "Alloys Used in Art Metal Work."

*No.* 54.—*Hanuman;* the monkey ally of *Rama;* copper and brass, cut through to show process of casting. *Madras*. Modern. H. 4 in.—726.

This specimen of art metal work is of peculiar interest, insomuch as it was apparently a compound casting showing on its surface two distinct metals, viz., bronze and brass very much interspersed. The figure was not of one metal altered in color in parts by superficial treatment, as inspection showed the color to be due to the metal itself. Owing to the intermixture of the metals—the way in which they protruded one beyond the other at different points, and the small quantity at parts of one metal over the other, such as the bracelets, armlets, for example—it was difficult to understand from outside examination how these figures were made. With the object of solving the question, it was considered that some light might be thrown on the subject if the casting were cut in halves from top to bottom. This was done, and immediately the whole process was explained, as it is quite clear that a core of copper was originally cast, of a shape showing due regard to the result desired, and that the brass was cast round the copper.

From what is known in connection with small Oriental castings, it is probable that the following process has been employed in the production of these double castings. First, a model has been carved in wax, of a shape and size necessary to bring out the copper where that metal is required at the surface, and leaving space where the yellow surface is desired for the future casting of brass. This wax model has then been moulded, the mould heated and the wax melted out, after which the copper has been cast in the mould. Then around this half figure, with its prominent parts, where necessary, more wax has been cast, and carved into the shape of the figure ultimately required. The whole has then been moulded, the wax removed as before, and the brass run into the mould, filling up the spaces existing between it and the copper core in the center. The double casting has then been removed, the brass filed down, wherever it might accidentally and unnecessarily have covered the copper, until the red metal was exposed, the whole being then chased and completed.

This casting is probably about 40 years old, and was made in Madras. The art of double casting, as represented by this figure, is very old (a thousand years or more), and has been practiced at, and almost entirely confined to, the east coast of the Madras Presidency.

Mr. Havell, of the School of Art of Madras, who has been engaged on a survey of art manufactures for the government, reported in 1887 that these castings were no longer made. Mr. C. Purdon Clarke thinks that if this be true, it is probably due to the high cost of production.

The rest of my remarks will be mainly devoted to the questions of patina and texture. The standard fineness of gold and silver wares is, as is well known, vigorously guarded by law, and articles of gold may only vary between the limits of 9 carats, or 37·5 per cent., and 22 carats, 91·66 per cent. of the precious metal, while silverwork always contains 92·5 per cent. of silver. In the latter case, the rigid adherence to the old standard of England, while securing integrity in the productions of the silversmiths, has, it is to be feared, exerted a prejudicial influence on the development of metal work. In this custom has much to answer for: we have become so accustomed to see wares of the precious metals with resplendent surfaces, that the public will barely tolerate, and certainly do not appreciate, the film of varnish which silver acquires when exposed to the atmosphere; we seem to have entirely shut ourselves out from the use of a large series of alloys, the beauty of which depends on the tarnish they gain, either by time or exposure, or by the far more rapid action of chemical agents.

Take the case of "presentation plate"—quite apart from the terrible examples presented by many of the articles which generally serve for this purpose—the question of weight always receives attention; the price is not paid for the craftsmanship, but the weight, the number of ounces, and not the originality of treatment, too often considered to be far more important in determining the choice. In the case of metal work we have been warned that such absence of "perception is fraught with infinite mischief, direct or indirect, to the development of art among us, tending as it does to divorce from it whole classes of industrial production, and incalculably narrowing the field of beauty in our lives."* The law is in no small measure responsible for the limitation of material, as the use of varied alloys in silver work is forbidden, so that the very restrictions which in the past have secured honesty in work have been fatal to progress in art.

(*To be continued.*)

## ANALYSIS OF SMOKELESS POWDER.

By C. ISTRATI.

THERE is nothing more difficult than to have to analyze a complex substance of the composition of which one has not the slightest idea. Especially is this so when the compound is explosive, as the case with a smokeless powder. In any case it is necessary to make a preliminary analysis, and to first endeavor to split the body into less complex bodies of which to make a qualitative analysis. Even then there remains the difficulty of estimating the relative quantities in which these bodies occur. Such a case, however, fell to my lot, having to analyze a smokeless powder concerning the composition of which I had not the slightest idea, and was, therefore, somewhat exercised as to how to proceed, and did not think I should succeed in finding out as easily as I did the composition of the powder I had to investigate.

This powder was in the form of small sticks, perfectly cylindrical, their diameter being less than a millimeter and their length about seven millimeters. The color was yellow, with a waxy appearance, and sufficiently soft to be easily squashed under one's finger nail. It burnt without explosion, and at the rate of about a meter in four minutes, the little cylinders being placed end on end. The powder was not soluble at all in water, and when burnt it left very little ash.

Dried at 105° C., it gave upon analysis the following results:

| | Per cent. |
|---|---|
| Carbon | 21·86 |
| Hydrogen | 3·33 |
| Nitrogen | 15·84 |

Some of the powder was then placed in an extraction apparatus and extracted with benzine. After several trials it was found that by this treatment the powder was only separated into two parts, which by their intimate mixture formed the greater part of the powder; with the exception that a small quantity of resin was found, about 0·5 per cent., with which the cylinders were probably covered to prevent their absorbing moisture from the air.

Of the two portions obtained by the benzine treatment, one was a colorless liquid which exploded when struck with a hammer, and was found to be nitro-glycerine. The other part was a light gray solid, which on analysis was found to be trinitro-cellulose, and to which the powder owed its inflammable properties. The results of the estimation of the percentage of these two ingredients were as follows:

| | Per cent. |
|---|---|
| Nitro-glycerine | 48·00 |
| Trinitro-cellulose | 51·50 |
| Resin | 0·50 |
| | 100·00 |

The resin only being added to form a protecting covering and to give adhesiveness to the particles.—*Bul. Soc. Sci. Bucuresci.*

[FROM THE AMERICAN JOURNAL OF SCIENCE.]

## THE INTERNAL WORK OF THE WIND.*

By S. P. LANGLEY.

PART III.—APPLICATION.

OF these irregular movements of the wind, which take place up, down, and on every side, and are accompanied of necessity by equally complex condensations and expansions, it will be observed that only a small portion, namely, those which occur in a narrow current whose direction is horizontal and sensibly linear, and whose width is only the diameter of the anemometer, can be noted by the instruments I have here described, and whose records alone are represented in the diagram. However complex the movement may appear as shown by the diagram, it is then far less so than the reality, and it is probable, indeed, that anything like a fairly complete graphical presentation of the case is impossible.

I think that on considering these striking curves (Figs. 1, 2, 3, 4 and 5) we shall not find it difficult to admit, at least as an abstract conception, that there is no necessary violation of the principle of the conservation of energy implied in the admission that a body wholly immersed in and moving with such a wind may derive from it a force which may be utilized in *lifting* the body, in a way in which a body immersed in the "wind" of our ordinary conception could not be lifted, and if we admit that the body may be lifted, it follows obviously that it may descend under the action of gravity from the elevated position, on a sloping path, to some distance in a direction opposed to that of the wind which lifted it, though it is not obvious what this distance is.

We may admit all this, because we now see (I repeat) that the apparent violation of law arises from a tacit assumption which we, in common with all others, may have made, that the wind is an approximately homogeneously moving body, because moving as a whole in one direction. It is, on the contrary, *always*, as we see here, filled (even if we consider only movements in some one horizontal plane) with amazingly complex motions, some of which, if not in direct opposition to the main movement, are relatively so, that is, are slower, while others are faster than this main movement, so that a portion is always opposed to it.

From this, then, we may now at least see that it is plainly within the capacity of an intelligence like that suggested by Maxwell, and which Lord Kelvin has called the "Sorting Demon," to pick out from the internal motions those whose direction is opposed to the main current, and to omit those which are not so, and thus *without the expenditure of energy* to construct a force which will act against the main current itself.

But we may go materially further, and not only admit that it is not necessary to invoke here, as Maxwell has done in the case of thermo-dynamics, a being having power and rapidity of action far above ours, but that in actual fact, a being of a lower order than ourselves, guided only by instinct, may so utilize these internal motions.

We might not indeed have conceived this possible, were it not that nature has already, to a large extent, exhibited it before our eyes in the soaring bird which sustains itself endlessly in the air with nearly motionless wings, for without this evidence of the possibility of an action which now ceases to approach the inconceivable, we are not likely, even if admitting its theoretical possibility, to have thought the mechanical solution of this problem possible.

But although to show how this physical miracle of nature is to be imitated, completely and in detail, may be found to transcend any power of analysis, I hope to show that this may be possible without invoking the asserted power of "aspiration" relative to curved surfaces, or the trend of upward currents, and even to indicate the probability that the mechanical solution of this problem may not be beyond human skill.

To this conclusion we are invited by the following consideration, among others.

We will presently examine the means of utilizing this potentiality of internal work in order to cause an inert body wholly unrestricted in its motion and wholly immersed in the current, to *rise;* but first let us consider such a body (a plane) whose movement is restricted to a horizontal direction, but which is free to move between frictionless vertical guides. Let it be inclined upward at a small angle toward a horizontal wind, so that only the vertical component of the pressure of the wind on the plane will affect its motion. If the velocity of the wind be sufficient, the vertical component of pressure will equal or exceed the weight of the plane, and in the latter case, the plane will rise indefinitely.

* A paper read (by title only) to the National Academy of Sciences, in April, 1893, and subsequently (in full) at the Aeronautical Congress at Chicago, August, 1893.—[Continued from SUPPLEMENT No. 946, page 15124.]

† "When the condors in a flock are wheeling round and round any spot, their flight is beautiful. Except when rising from the ground, I do not recollect ever having seen one of these birds flap its wings. Near Lima, I watched several for nearly half an hour without once taking off my eyes. They moved in large curves sweeping in circles, descending and ascending without once flapping. As they glided close over my head, I intently watched, from an oblique position, the outlines of the separate and terminal feathers of the wing; and if there had been the least vibratory movement these would have blended together, but they were seen distinct against the blue sky. The head and neck were moved frequently and apparently with force, and it appeared as if the extended wings formed the fulcrum on which the movements of the neck, body, and tail acted. If the bird wished to descend, the wings for a moment collapsed; and then when again expanded with an altered inclination the momentum gained by the rapid descent seemed to urge the bird upward, with the even and steady movement of a paper kite. In the case of any bird *soaring*, its motion must be sufficiently rapid so that the action of the inclined surface of its body on the atmosphere may counterbalance its gravity. The force to keep up the momentum of a body moving in a horizontal plane in that fluid (in which there is so little friction) cannot be great, and this force is all that is wanted. The movement of the neck and body of the condor, we must suppose, is sufficient for this. However this may be, it is truly wonderful and beautiful to see so great a bird, hour after hour, without any apparent exertion, wheeling and gliding over mountain and river."—Darwin's *Journal of the Various Countries Visited by H. M. S. Beagle*, pp. 223, 224.

* Sir Frederick Leighton.

Thus to take a concrete example, if the plane be a rectangle whose length is six times its width, having an area of 2·3 square feet to the pound, and be inclined at an angle of 7°, and if the wind have a velocity of 36 feet per second, experiment shows that the upward pressure will exceed the weight of the plane, and the plane will rise, if between vertical nearly frictionless guides, at an increasing rate, until it has a velocity of 2·52 feet per second,* at which speed the weight and upward pressure are in equilibrium. Hence there are no unbalanced forces acting, and the plane will have attained a state of uniform motion.

For a wind that blows during 10 seconds, the plane will therefore rise about 25 feet. At the beginning of the motion, the inertia of the plane makes the rate of rise less than the uniform rate, but at the end of 10 seconds, the inertia will cause the plane to ascend a short distance after the wind has ceased, so that the deficit at the beginning will be counterbalanced by the excess at the end of the assigned interval.

We have just been speaking of a material heavy plane permanently sustained in vertical guides, which are essential to its continuous ascent in a uniform wind, but such a plane will be lifted and sustained *momentarily* even if there be no vertical guides, or in the case of a kite, even if there be no cord to retain it, the inertia of the body supplying for a brief period the office of the guides or of the cord. If suitably disposed, it will, as the writer has elsewhere shown, under the resistance to a horizontal wind, imposed only by its inertia, commence to move, not in the direction of the wind, but nearly vertically. Presently, however, as we recognize, this inertia must be overcome, and as the inclined plane takes up more and more the motion of the wind, the lifting effect must grow less and less (that is to say, if the wind be the approximately homogeneous current it is commonly treated as being), and finally ceasing altogether, the plane must ultimately fall. If, however, a counter current is supposed to meet this inclined plane, before the effect of its inertia is exhausted, and consequently before it ceases to rise, we have only to suppose the plane to be rotated through 180° about a vertical axis, without any other call for the expenditure of energy, to see that it will now be lifted still higher, owing to the fact that its inertia now reappears as an active factor. The annexed sketch (Fig. 6) shows a typical representation

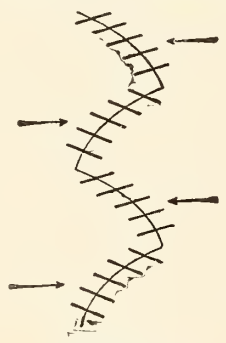


FIG. 6.

of what might be supposed to happen with a model inclined plane freely suspended in the air, and endowed with the power of rotating about a vertical axis so as to change the aspect of its constant inclination, which need involve no (theoretical) expenditure of energy, even although the plane possess inertia. We see that this plate would rise indefinitely by the action of the wind in alternate *directions*.

The disposition of the wind which is here supposed to cause the plane to rise, appears at first sight an impossible one, but we shall next make the important observation that it becomes virtually possible by a method which we will now point out, and which leads to a practicable one which we may actually employ.

Fig. 7 shows the wind blowing in one constant direc-

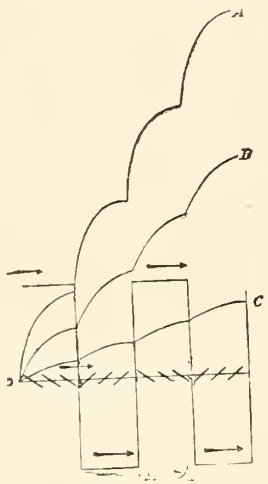



FIG. 7.

tion, but alternately at two widely varying velocities, or rather (in the extreme case supposed in illustration), where one of the velocities is negligibly small, and where successive pulsations in the same direction are separated by intervals of calm.

A frequent alternation of velocities, united with constancy of absolute direction, has previously been shown here to be the ordinary condition of the wind's motion; but attention is now particularly called to the fact that while these unequal velocities may be in the same direction as regards the surface of the earth, yet as regards the *mean* motion of the wind they are in opposite directions, and will produce on a plane, whose inertia enables it to sustain a sensibly uniform motion with the mean velocity of this variable wind, the same lifting effect as if these same alternating winds were in absolutely opposed directions, provided that the constant inclination of the plane alternates in its aspect to correspond with the changes in the wind.

It may aid in clearness of conception, if we imagine a set of fixed co-ordinates, X Y Z, passing through 0, and a set of movable co-ordinates, *x y z*, moving with the velocity and the direction of the mean wind. If the moving body is referred to these first only, it is evidently subject to pulsations which take place in the same directions on the axis of X, but it must be also evident that if referred to the second or movable co-ordinates, these same pulsations may be and are in opposite directions. This, then, is the case we have just considered, and if we suppose the plane to change the aspect* of its (constant) inclination as the direction of the pulsations changes, it is evident that there must be a gain in altitude with every pulsation, while the plane advances horizontally with the velocity of the mean wind.

During the period of maximum wind velocity, when the wind is moving faster than the plane, the rear edge of the latter must be elevated. During the period of minimum velocity, when the plane, owing to its inertia, is moving faster than the wind, the front edge of the plane must be elevated. Thus the vertical component of the wind pressure, as it strikes the oblique plane, tends in both cases to give it a vertical upward thrust. So long as this thrust is in excess of the weight to be lifted, the plane will rise. The rate of rise will be greatest at the beginning of each period, when the relative velocity is greatest, and will diminish as the resistance produces "drift," *i. e.*, diminishes relative velocity. The curved line, O B, in the vignette, represents a typical path of the plane under these conditions.

It follows from the diagram (Fig. 6) that, other things being equal, the more frequent the wind's pulsations, the greater will be the rise of the plane, for since during each period of steady wind, the rate of rise diminishes, the more rapid the pulsations, the nearer the mean rate of rise will be to the initial rate. The requisite frequency of pulsations is also related to the inertia of the plane, as the less the inertia, the more frequent must be the pulsations, in order that the plane shall not lose its relative velocity.

It is obvious that there is a limit or weight which cannot be exceeded if the body is to be sustained by any such fluctuations of velocity as can be actually experienced. Above this limit of weight the body will sink. Below this limit the lighter the body is the higher it will be carried, but with increasing variability of speed. That body, then, which has the greatest weight per unit of surface will soar with the greatest steadiness, if it soar at all, not on account of this weight *per se*, but because the weight is an index of its inertia.

The reader who will compare the results of experiments made with any artificial flying models, like those of Penaud, with the weights of the soaring birds, as given in the tables by M. Mouillard, or other authentic sources, cannot fail to be struck with the great weight in proportion to wing surface which nature has given to the soaring bird, compared with any which man has yet been able to imitate in his models.

This fact of the weight of the soaring bird in proportion to its area has been again and again noted, and it has been frequently remarked that without weight the bird could not soar by writers who felt that they could very safely make such a paradoxical statement, in view of the evidence nature everywhere gave that this weight was indeed in some way necessary to rising. But these writers have not shown, so far as I remember, how this necessity arises, and this is what I now endeavor to point out.†

It has not here been shown what limit of weight is imposed to the power of an ordinary wind to elevate and sustain, but it seems to me, and I hope that it may seem to the reader, that the evidence that there is *some* weight which the action of the wind is sufficient to permanently sustain under these conditions in a free body has a demonstrative character, although no quantitative formula is offered at this stage of the investigation. It is obvious that, if this weight is sustainable at any height, gravity may be utilized to cause the body (which we suppose to be a material plane) to descend on an inclined course to some distance, even against the wind.

I desire in this connection to remark that the preceding experiments and deductions showing that a material free plane,‡ possessing sufficient inertia, may, in theory, rise indefinitely by the action of an ordinary wind, without the expenditure of work from any internal source (as well as those statements which follow), when these explanations are once made, have a character of obviousness, which is due to the simplicity of the enunciation, but not, I think, to the familiarity of the explanation, for though attention is beginning to be paid by meteorologists to the rapidity of these wind fluctuations, I am not aware that their effects have been so exhibited, or especially that they have been presented in this connection, or that the conclusions which follow have been drawn from them.

We have here seen, then, how pulsations of sufficient amplitude and frequency, of the kind which present themselves in nature, may, in theory, furnish energy not only sufficient to sustain, but actually to elevate a heavy body moving in and with the wind at its mean rate.

It is easy to now pass to the practical case, which has been already referred to, and which is exemplified in nature, namely, that in which the body (*e. g.*, the bird soaring on rigid wings, but having power to change its inclination) uses the elevation thus gained to move against the wind without expending any sensible amount of its own energy. Here the upward motion is designedly arrested at any convenient stage, *e. g.*, at each alternate pulsation of the wind, and the height attained is utilized so that the action of gravity may carry the body by its descent in a curvilinear path (if necessary) against the wind. It has just been pointed out that if some height has been attained, the theoretical possibility of *some* advance against the wind in so falling hardly needs demonstration, although it may not unnaturally be supposed that the relative advance so gained must be insignificant compared with the distance traveled by the mean wind while the body was being elevated, so that on the whole the body is carried by the wind further than it advances against it.

This, however, probably need not be, in fact, the case, there being, as it appears to me from experiment and from deduction, every reason to believe that under suitable conditions the advance may be greater than the recession, or that the body falling under the action of gravity along a suitable path may return against the wind, not only from Z to O, the point of departure, but further, as is here shown.

I repeat, however, that I am not at the moment undertaking to demonstrate how the action is mechanically realizable in actual practice, but only that it is possible. It is for this purpose and to understand more exactly that it can be effected, not only by the process indicated in Fig. 7, but by another and probably more usual one (and nature has still others at command), that I have considered another treatment of the same conditions, of wind pulsations always moving in the same horizontal direction, but for brief periods, interrupted by equal intervals of calm. In Fig. 8 we sup-

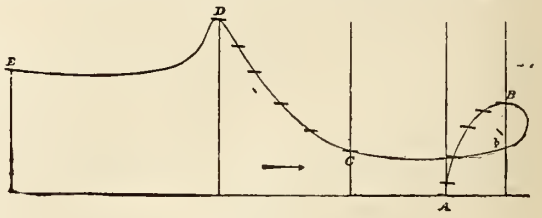



FIG. 8.

pose the body to use the height gained in each pulsation, to enable it to descend after each such pulsation and advance against the direction of the wind.

The portion, A B, of the curve represents the path of the plane surface from a state of rest at A, where it has a small upward inclination toward the wind. If a horizontal wind blow upon it in the direction of the arrow, the first movement of the plane will not be in the direction of the wind, but, as is abundantly demonstrated by the writer in "Experiments in Aerodynamics," it will rise in a nearly vertical direction, if the angle be small.

The wind continuing to blow in the same direction, at the end of a certain time the plane, which has risen (owing to its inertia and in spite of its weight) to the successive positions shown, is taking up more and more of the horizontal velocity of the wind and consequently opposing less resistance to it, and therefore moving more and more laterally and rising less and less at every successive instant.

If the wind continued indefinitely, the plane would ultimately take up its velocity, and finally, of course, fall when this inertia ceased to oppose resistance to the wind's advance. I have supposed, however, the wind pulsation to cease at the end of a certain brief period, and, to fix our ideas, let us suppose this period to be five seconds. At this moment the period of calms begins, and now let the plane, which is supposed to have reached the point, B, change its inclination about a horizontal axis to that shown in the diagram, falling at first nearly vertically, with its edge on the line of its descent, so as to acquire speed, and, this speed acquired, by constantly changing its angle, glide down the curve, B *b* C, so that the plane shall be tangential to it at every point of its descending advance. At the end of five seconds of calm it has reached the position, C, near the lowest point of its descent, which there is no contradiction to known mechanical laws in supposing *may* be higher than A, and which, in fact, according to the most accurate data the writer can gather, *is* higher in the case of the above period and in the case of such an actual plane as has been experimented upon by him.

Now, having reached C, at the end of the five seconds' calm, if the wind blow in the same direction and velocity as before, it will again elevate the plane on the latter's presenting the proper angle, but this time under more favorable circumstances, for at this time the plane is already in motion in a direction opposed to that of the wind, and is already higher than it was in its original position, A. Its course, therefore, will be nearly that along the curve, C D, during all which time it maintains the original angle, *a*, or one very slightly less. Arrived at D, and at the instant when the calm begins, it falls with varying inclination to the lowest position, E (which may be higher than C), which it attains at the end of the five seconds of calm, then rises again (still nearly at the angle, *a*), to a higher position, and so on; the alternation of directions of motion, at the end of each pulsation, growing less and less sharp, and the path finally taking the character of a sinuous curve. We have assumed that the plane goes against the wind and rises at the same time, in order to illustrate that this is possible, though either alternative may be employed, and the plane, in theory at least, may maintain, on the whole, a rapid and nearly horizontal, or a slow and nearly vertical course, or anything between.

It is not meant, either, that the alternations which would be observed in nature are as sharp as those here represented, which are intentionally exaggerated, while in all which has just preceded, by an equally intentional exaggeration of the normal action, the wind pulsations have been supposed to alternate with absolute calm. This being understood, it is scarcely necessary to point out that if the calm is not absolute, but if there are simply frequent successive winds or pulsations of wind of considerably differing velocity (such as the anemometer observations show are realized in nature), that the same general effect will obtain,*

* See "Experiments in Aerodynamics," by S. P. Langley, *Smithsonian Contributions to Knowledge*, 1891.

* We do not for the moment consider how this change of aspect is to be mechanically effected; we only at present call attention to the fact that it involves, in theory, no expenditures of energy.

† It is, perhaps, not superfluous to recall here that, according to the researches of Rankine, Froude and others, a body moulded in wave line curves would, if frictionless, continue to move indefinitely against an opposed wind in virtue of inertia and once acquired velocity, and also to recall how very small the effect of fluid friction in the air has been shown to be (by the writer in a previous investigation).

‡ I use the word "plane," but include in the statement all suitable modifications of a curved surface.

I desire to recall attention to the paragraph in "Experiments in Aerodynamics," in which I caution the reader against supposing that by investigating plane surfaces I imply that they are the best form of surface for flight; and I repeat here that, as a matter of fact, I do not believe them to be so. I have selected the plane simply as the best form for preliminary experiment.

* The rotation of the body about a vertical axis so as to change the aspect of the inclination as in the first figure, may be illustrated by the well-

though we are not entitled to assume from any demonstration thus far given that the total advance will be necessarily greater than that of the whole distance the mean wind has traveled. It may also be observed that the actual actions of the soaring bird may be and doubtless are more complex in detail than those of this diagram, while yet in their entirety depending on the principles it sets forth.

The theoretical possibility, at least, will now, it is hoped, be granted, not only of the body's rising indefinitely, or of its descending in the interval of calm to a higher level, C, than it rose from at A, but of its advancing against the calm or light wind through a distance, B C, greater than that of A B, and so on. The writer, however, repeats that he has reason to suppose from the data obtained by him, that this is not only a theoretical possibility, but a mechanical probability under the conditions stated, although he does not here offer a quantitative demonstration of the fact, other than by pointing to the movements of the soaring bird and inviting their reconsideration in the light of the preceding statements.

The bird, by some tactile sensibility to the pressure and direction of the air, is able, in nautical phrase, to "see the wind,"* and to time its movements, so that without any reference to its height from the ground, it reaches the lowest portion of its descent near the end of the more rapid wind pulsation. But the writer believes that to cause these adaptive changes in an otherwise inert body, with what might almost be called instinctive readiness and rapidity, does not really demand intelligence or even instinct, but that the future aerodrome may be furnished with a substitute for instinct in what may, perhaps, allowably be called a mechanical brain, which yet need not, in his opinion, be intricate in its character. His reasons for this statement, which is not made lightly, must, however, be reserved for another time.

It is hardly necessary to point out that the nearly inert body in question may also be a human body, guided both by instinct and intelligence, and that there may thus be a sense in which human flight may be possible, although flight depending wholly upon the action of human muscles be forever impossible.

Let me resume the leading points of the present memoir in the statement that it has been shown:

(1) That the wind is not even an approximately uniform moving mass of air, but consists of a succession of very brief pulsations of varying amplitude, and that, relatively to the mean movement of the wind, these are of varying direction.

(2) That it is pointed out that hence there is a potentiality of "internal work" in the wind, and probably of a very great amount.

(3) That it involves no contradiction of known principles to declare that an inclined plane, or suitably curved surface, heavier than the air, freely immersed in, and moving with the velocity of the mean wind, can, if the wind pulsations here described are of sufficient amplitude and frequency, be sustained or even raised indefinitely without expenditure of internal energy other than that which is involved in changing the aspect of its inclination at each pulsation.

(4) That since (A) such a surface, having also power to change its inclination, *must* gain energy through falling during the slower and expend energy by rising during the higher velocities; and that (B) since it has been shown that there is no contradiction of known mechanical laws in assuming that the surface *may* be sustained or *may* continue to rise indefinitely, the mechanical possibility of some advance against the direction of the wind follows immediately from this capacity of rising. It is further seen that it is at least possible that this advance against the wind may not only be attained relatively to the position of a body moving with the speed of the mean wind, but absolutely, and with reference to a fixed point in space.

(5) The statement is made that this is not only mechanically possible, but that in the writer's opinion, it is realizable in practice.

Finally, these observations and deductions have, it seems to me, an important practical application, not only as regards a living creature like the soaring bird, but still more as regards a mechanically-constructed body, whose specific gravity may probably be many hundred or even many thousand times that of the atmosphere. We may suppose such a body to be supplied with fuel and engines, which would be indispensable to sustain it in a calm, and yet which we now see might be ordinarily left entirely inactive, so that the body could supposably remain in the air and even maintain its motion in any direction without expending its energy, except as regards the act of changing the inclination or aspect which it presents to the wind, while the wind blew.

The final application of these principles to the art of aerodromics seem to be that while it is not likely that the perfected aerodrome will ever be able to dispense altogether with the ability to rely at intervals on some internal source of power, it will not be indispensable that this aerodrome of the future shall, in order to go any distance—even to circumnavigate the globe without alighting—need to carry a weight of fuel, which would enable it to perform this journey under conditions analogous to those of a steamship, but that the fuel and weight need only be such as to enable it to take care of itself in exceptional moments of calm.

Smithsonian Institution, Washington, D. C., August, 1893.

* Mouillard.

## "THOSE COCOONS RESEMBLING PINE CONES?"

By Prof. C. V. RILEY.

MR. JAMES WEIR, Jr.'s, article on "Pine Cones, or Cocoons?" in the SCIENTIFIC AMERICAN for January 20, 1894, is interesting, and his figures show that there is a very slight resemblance between the bags of the bag worm (*Thyridopteryx ephemeraeformis*) and certain pine cones. As a matter of fact, however, the article is unfortunately full of error as to the natural history of the insect, and the point of protective resemblance is not sustained when we take into account the facts regarding the habits of the species.

The common bag worm occurs on all sorts of trees. In the arboretum on the grounds of the Department of Agriculture, where many species of trees of many orders from all parts of the world are grown, hardly a species is exempt from the attacks of this insect. The bag which the larva spins is the same on every species of tree on which the insect is found; that is to say, it is the same in shape, size and general color. The bits of leaves or twigs which the insect uses to strengthen the bag with, however, will differ with the material nearest at hand, but one of these bags upon a deciduous tree will frequently look as much like a pine cone as one which occurs upon a pine tree. It is difficult to see where Mr. Weir could have gained his strikingly erroneous ideas as to the life history of the insect. He seems never to have seen the bags of the young or half grown larvæ, since he states that the

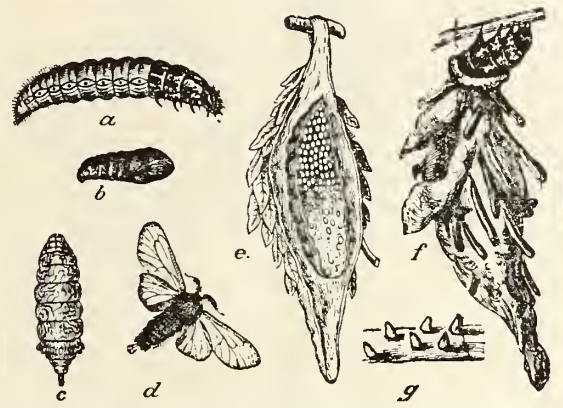



FIG. 1.—*Thyridopteryx ephemeræformis:* *a*, larva; *b*, male chrysalis; *c*, female moth; *d*, male moth; *e*, follicle and puparium cut open to show eggs; *f*, full grown larva with bag; *g*, young larvæ with their conical upright coverings; all natural size.

larva feeds upon the couch or dog grass, hiding during the day and feeding in the evening. He has probably found some cut-worm whose habits he thus describes, and assumes that this is the insect which afterward spins the bag in the pine trees. The fact is that so soon as the eggs in the old female bags hatch, and the little bag worm larvæ crawl forth into the outside world, they begin to construct bags for themselves, and these bags they carry about with them during their entire larval life, enlarging them with each moult until they fall to the ground, when they utilize them for pupation. In the SUPPLEMENT for September 28, 1878, and some weeks later, under the title of "That Fatherless and Motherless Race," I published some facts that were then new about this insect, but perhaps the following more detailed account from my later writings will prove of sufficient interest to Mr. Weir and others to justify publication.

*The Eggs.*—During the winter time the dependent sacs or bags of this species may be seen hanging on the twigs of almost every kind of tree. If they happen to be on coniferous trees—and they are usually more abundant on these than on deciduous trees—they are not infrequently mistaken for the cones. In reality they are the coverings spun by our worm, and they serve not only as a protection to it, but also to the eggs. Upon cutting open the larger of these bags in winter time they will be found to contain the shell of a chrysalis (technically called the puparium), which is filled with numerous small yellow eggs (Fig. 1, *e*). Each of these is a little over one millimeter in length, obovate in form, and surrounded by a delicate, fawn colored, silky down. In this condition the eggs remain from fall throughout the winter and early spring.

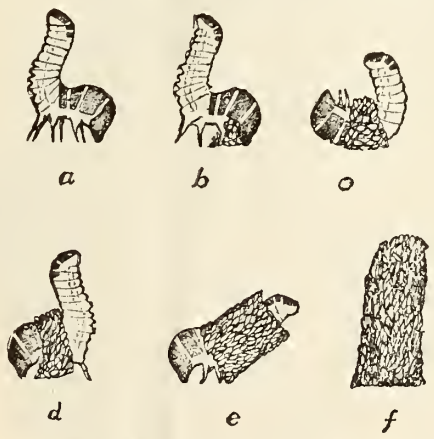



FIG. 2.—*Thyridopteryx ephemeræformis:* How the young larva prepares its bag.

*The Larva and its Bag.*—About the middle of May in this latitude the egg hatches into small but active larvæ, which at once commence to construct a portable case or bag in which to live. The way in which this bag is prepared is curious (Fig. 2), and has been well described by Mr. H. G. Hubbard. The young larva crawls on a leaf and gnawing little bits from the surface, fastens these together with fine silk, produces a narrow elongate band, which is then fastened at both ends on to the surface of the leaf by silky threads. Having secured itself from falling down by some threads, it now straddles this band and, bending its head downward (Fig. 2, *b*), makes a dive under it, turns a complete somersault and lies on its back, held down by the band (Fig. 2, *c*). By a quick turning movement the larva regains its feet, the band now extending across its neck (Fig. 2, *d*). It then adds to the band at each end until the two ends meet, and they are then fastened together so as to form a kind of narrow collar which encircles the neck of the worm. Far from resting, it now busies itself by adding row after row to the anterior or lower end of the collar, which thus rapidly grows in girth and is pushed further and further over the maker (Fig. 2, *e*). The inside of this bag is now carefully lined with an additional layer of silk, and the larva now marches off, carrying the bag in an upright position (Fig. 1, *g*, and Fig. 2, *f*). When in motion or when feeding, the head and thoracic segments protrude from the lower end of the bag, the rest of the body being bent upward and held in this position by the bag. As the worms grow they continue to increase the bags from the lower end and they gradually begin to use larger pieces of leaves, or bits of twigs or any other small objects for ornamenting the outside. Thus the bags will differ according to the different kind of tree or shrub upon which the larva happens to feed; those found on coniferous trees being ornamented with the filiform pine leaves, usually arranged lengthwise on the bag, while those on the various deciduous trees are more or less densely

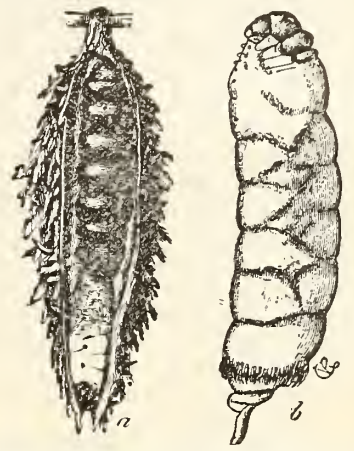



FIG. 3.—*Thyridopteryx ephemeræformis:* *a*, follicle cut open to show the manner in which the female works from her puparium and reaches the end of the bag, natural size; *b*, female extracted from her case, enlarged.

and irregularly covered with bits of leaves interspersed with pieces of twigs. When kept in captivity the worms are very fond of using bits of cork, straw, or paper, if such are offered to them. When the bags, with the growth of the larva, get large and heavy, they are no longer carried, but allowed to hang down (Fig. 1, *f*). The worms undergo four moults, and at each of these periods they close up the mouth of their bags to remain within until they have cast their skin and recovered from this effort. The old skin, as well as the excrement, is pushed out through a passage which is kept open by the worms at the extremity of the bag.

The young larva is of a nearly uniform brown color, but when more full grown that portion of the body which is covered by the bag is soft, of light brown color and reddish on the sides, while the head and thoracic joints are horny and mottled with dark brown and white (Fig. 1, *a*). The numerous hooks with which the small, fleshy prolegs on the middle and posterior part of the body are furnished enable the worm to firmly cling to the silken lining of the bag, so that it can with difficulty be pulled out.

The bag of the full grown worm (Fig. 1, *f*) is elongate-oval in shape, its outlines being more or less irregular on account of the irregularities in the ornamentation above described. The silk itself is extremely tough and with difficulty pulled asunder.

The larvæ are poor travelers during growth, and though, when in great numbers, they must often wander from one branch to another, they rarely leave the tree upon which they were born unless compelled to do so by hunger through the defoliation of the trees. When full grown, however, they develop a greater activity, especially when very numerous, and, letting themselves down by a fine silken thread, travel fast enough across sidewalks or streets and often for a considerable distance until they reach another tree, which they ascend. This migratory desire is instinctive; for should the worms remain on the same tree they would become so numerous as to necessarily perish for the want of food.

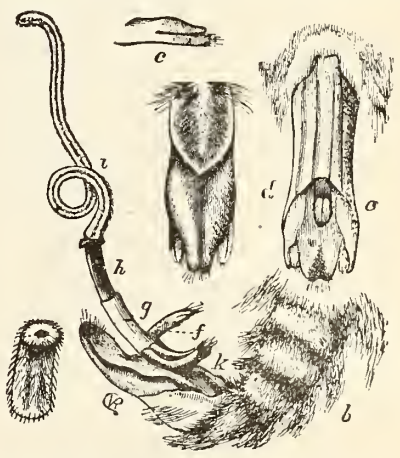



FIG. 4.—*Thyridopteryx ephemeræformis:* *b*, the end of male abdomen from the side, showing genitalia extended; *c*, genitalia inrepose, ventral view; *d*, do., dorsal view enlarged.

*Pupation.*—The bags of the worms which are to produce male moths attain rather more than an inch in length, while those which produce females attain nearly double this size. When ready to transform, the larva firmly secures the anterior end of the bags to a twig or branch, and instinct leads it to reject for this purpose any deciduous leaf or leaf stem with which it would be blown down by the winds. The inside of the bag is then strengthened with an additional lining of silk, and the change to chrysalis is made with their heads always downward. The chrysalis is of a dark brown color, that of the male (Fig. 1,

known habit of many soaring birds of moving in small closed curves or spirals, but it may also be observed, in view of the fact that even in intervals of relative calm during which the body descends, there is always some wind; that in making the descents, if the body, animate or inanimate, maintain its direct advance, this wind tends to strike on the upper side of the plane or pinion. Mr. G. E. Curtis offers the suggestion that the soaring bird avoids such a position when possible, and therefore turns at right angles to or with the wind, and that this may be an additional reason for his well-known habit of moving in spirals.

*b*) being only half the size of that of the female (Fig. 1, *e*, and Fig. 3, *a*).

*The Imago or Perfect Insect.*—After a lapse of about three weeks from pupation a still greater difference between the two sexes becomes apparent. The male chrysalis works its way to the lower end of the bag and half way out of the opening at the extremity. Then its skin bursts and the imago appears as a winged moth with a black, hairy body and glassy wings (Fig. 1, *d*). It is swift of flight, and, owing to its small size and transparent wings, is rarely observed in nature. The life duration of this sex is also very short. The female imago is naked (save a ring of pubescence around the end of the body of yellowish white color) and entirely destitute of legs and wings (Fig. 1, *c*, and Fig. 3,*b*). She pushes her way partly out of the chrysalis, her head reaching to the lower end of the bag, where, without leaving the same, she awaits the approach of the male. The manner in which the chrysalis shell is elongated and reaches to the end of the bag is shown in Fig. 3, *a*, and an enlarged side view of the female, showing the details of structure, is shown at *b* in the same figure. The extensibility of the male genitalia, which permits him to reach the female within her bag, is set forth in the accompanying Fig. 4, where the parts are shown at rest, *c* and *d*, and in action, *b*. Fertilization being accomplished, the female works her way back within the chrysalis skin and fills it with eggs, receding as she does so toward the lower end of the bag, where, having completed the work of oviposition, she forces, with a last effort, her shrunken body out of the opening, drops to the ground, and perishes. When the female has withdrawn, the slit at the head of the puparium and the elastic opening of the bag close again, and the eggs thus remain securely protected till they are ready to hatch the ensuing spring.

## THE CONDOR OF THE ANDES.

By S. L. CLAYES.

AMONG the raptores, or rapacious birds, the condor holds first rank by reason of its enormous size and unparalleled voracity. It is found along the whole chain of the Andes, through Mexico, Chile, Peru and Patagonia to the Straits of Magellan, and Lewis and Clarke claim to have seen it even among the Rocky Mountains, near the source of the Missouri. But the Andes of South America is the native habitat and stronghold of these birds. They are most abundant in Chile and Peru, though even there they are not found in flocks, three or four being as many as are usually seen together. They have sometimes been called the great vultures of the Andes, and in many essential particulars they resemble the vultures of the Eastern Hemisphere.

When the bird was first seen by the Spanish conquerors of the New World, its strength and bulk so impressed them that imagination was aroused, and they likened it to the rokh of Arabian story, some even claiming it to be identical with the famous bird "which is able to trusse an elephant." Putting aside these romantic statements, even among naturalists of repute there were once the most exaggerated stories current in regard to size. Eighteen feet were gravely given by De Marchais as the actual measurement from tip to tip of the extended wings of a condor. "A width so enormous," he says, "that the bird can never enter a forest," and declares that a single one will attack a man or carry off a stag. Garcillosso states that there were some condors killed by the Spanish in Peru which measured fifteen or sixteen feet from the point of one wing to that of the other, and claims that there is a certain tribe of Indians which adores them. He adds that two will attack, overcome and devour a bull, and that a single bird will kill a boy of twelve years old. As Veillot justly says: "It was with the condor as with the Patagonians—both shrank before examination." Even Buffon exaggerated their size.

While observation has modified earlier reports, condors are still acknowledged to be the largest of known flying birds. Humboldt confesses that at first they appeared to him to be of colossal size, but says that an actual measurement corrected the illusion. He found none that exceeded nine feet in stretch of wing, and was assured by many inhabitants of Quito that they had never shot any of more than eleven feet. But this is less than the estimate of Tschudi, an accomplished zoologist and most careful and reliable authority, who in one place gives the wings an expansion of "from twelve to thirteen feet," and in another says: "I measured a very large male condor, and the width from the tip of one wing to the tip of the other was fourteen English feet and two inches, an enormous expanse of wing, not equaled by any other bird except the white albatross." But far from "trussing an elephant," Tschudi asserts that it is impossible for the condor to lift even so large a creature as a sheep from the ground, assuring his readers "he cannot when flying carry a weight exceeding eight or ten pounds." An old male condor belonging to the Zoological Society of London, which was considered a very fine specimen, measured eleven feet from tip to tip of his outstretched wings and four feet nine inches in length. Darwin, in his "Voyage of a Naturalist," writes of the first he shot: "It measured from tip to tip of the wings eight and a half feet and from beak to tail four feet."

Despite its immense size and weight the condor possesses the power of rising in its flight to a greater distance above the earth than any other bird; and Darwin speaks rapturously of its grace of motion on the wing. "When the condors are wheeling in a flock, round and round any spot, their flight is beautiful. Except when rising from the ground, I do not recollect ever to have seen one of these birds flap its wings. Near Lima I watched several for nearly half an hour without once taking off my eyes; they moved in large curves, sweeping in circles, descending and ascending, without giving a single flap. It is truly wonderful and beautiful to see so great a bird, hour after hour, without any apparent exertion, wheeling and gliding over mountain and river." Humboldt claims that it soars to an altitude of at least twenty thousand feet above the sea. From the Cave of Autisana, which is at an elevation of 12,958 feet above the Pacific Ocean, he observed a condor rise perpendicularly to a still greater height of 6,876 feet. Other authorites state that it reaches a height of six miles above the sea level, which is about six times the height of the ordinary clouds.

The bird from flying at this extreme elevation, where the air must be so highly rarefied, will drop suddenly to the valleys, thus in the briefest time passing through an almost incredible change of temperature. At such a height the air cells of the condor, when they have been filled in the lower regions, must be inflated in the most extraordinary manner. But the great bird loves the heights. They are his chosen home. Hunger alone drives him to the plains. As soon as his appetite is satiated he leaves them, appearing to be oppressed by the higher temperature and increased weight of the atmosphere, and returns to regions far above the clouds, where the air is so rarefied that a man can hardly breathe. High up as the eye can reach he may be seen describing his graceful circles against the blue. From this or even a more lofty point of vantage, he brings his telescopic eyes to bear upon the earth, eagerly scanning the movements of the herds for the fall of some weakening member of the flock. No sooner does a poor creature drop than down rush the condors to the feast.

In spite of the keenness of a hunger sharpened by one knows not how many days of watching upon the wing at that frigid altitude, our condor begins his repast daintily, tasting first the eyes and tongue, his chosen tid-bits. But soon, fired by the sight of the beautiful banquet which death has spread for him, he tears the tough hide, and, wildly pulling with his beak, pushing with his feet, and flapping his wide wings, gorges himself, gulping down great bits of flesh, and riots without stint until he can hold no more. Fairly drunken with his revolting feast, he no longer has power to raise himself upon the wing. Knowing this, the Indians will often place a dead animal as a lure upon the plains. When the birds have become gorged and unable to fly, the Indians appear and noose them with a lasso, a sport they find scarcely less exciting than the Spaniard does his bull fight.

So great is its tenacity of life that "when a condor is caught there is a fight, and a stout one, before it is killed," says an eye witness. Humboldt, who was present at the killing of one, tells that after having strangled it with a lasso the Indians hung it by the neck upon a tree, pulling vigorously upon its legs. When at length they took it down, apparently quite dead, "the bird got up and walked off as if nothing had happened. Then a pistol was fired at it, the man who fired standing within less than four paces. Three balls hit the living mark, wounding it in the neck, chest and abdomen; the bird kept its legs. A fourth ball broke its thigh. Then the condor fell to the ground, but did not die of its wounds till half an hour had elapsed."

The earlier tales of the condor's powers seem, like those of his size, to have been greatly exaggerated. Now the birds are no longer credited with particular ferocity. It is even claimed that their talons are not formidable, being too weak to seriously lacerate; that the natives do not fear them; that the little Indian children play about their parents while their fathers are engaged in collecting snow for sale in towns; that the babies with their parents sleep in safety in their near vicinity, and we have the assurance of Humboldt that he never heard one of them had been attacked or killed. He tells us, however, that two of the birds might prove dangerous if opposed to one man. Sir Francis Head's tale of the fight of a Cornish miner of his party with a condor proves that a man can conquer *one*. Still, Sir Francis reports the man to have declared that "he never had such a battle in his life; that he put his knee upon the bird's breast and tried with all his strength to twist its neck, but the condor, objecting to this, struggled violently, and as several others were flying over his head, he expected they would attack him. At last he succeeded in killing his antagonist, and with great pride showed me the large feathers from his wings; but when the third horseman came in, he told us he had found the condor in the path, but not quite dead." Darwin states on the authority of the Chileno countrymen that "the condor will live and retain its vigor between five and six weeks without eating."

The condor builds no nest, but choosing some isolated crag which towers thousands of feet above the level of the sea into the regions of perpetual snow, it there deposits two eggs upon the bare rock. The eggs are three or four inches in length and white as the purest ivory. After an incubation of about sixty days the young condor is hatched quite bare of feathers, its body being covered for several months with a whitish down, or frizzled hair, something like that which we find upon young owls. This down so exaggerates the size of the condor chick as to make it appear nearly as large as an adult. Darwin writes: "It is said that the young condors cannot fly for an entire year, and long after they are able to do so they continue to roost at night and hunt by day with their parents."

The young birds are of a brownish tint, while the general color of the mature birds is black, being brightest in the older males. This fact gave rise to a mistaken belief which was at one time current that there were two species of condors. The feathers, with the exception of the wing coverts and the secondary quill feathers, are a bright black, generally mixed with a grayish tinge. The wings are long and extremely powerful, the quill feathers measuring from two to three feet in length. The wing coverts in the females are blackish gray; in the males they are white at the points and frequently for half their length, often enabling one to thus distinguish the sexes at some distance. In both male and female the secondary quill feathers are white on the outer side. Ulloa asserts that "in the colder parts of Peru the skin is so closely covered with feathers that eight or ten balls may be heard to strike without penetrating its body." Both male and female wear about the lower part of the neck a ruff of light, downy feathers, marking the line of separation between the naked skin and the densely feathered parts below. The head and neck, wholly bare of feathers, are covered with a hard, coarse skin, deeply wrinkled and folded upon itself, of reddish-brown color, upon which some dark hairs are sparsely scattered. In the male the head is crowned with a sort of comb, firm, oblong in shape, and covered with the same rough skin as is the head. It lies along the beak, nearly to its extremity, covering the large oval nostrils, but it is so unattached at its lower end as to permit a free passage of the air for breathing. The male also bears upon its neck a loose membrane or wattle, similar to that of the turkey, and like it, capable of being dilated at the pleasure of the bird. The skin of the neck is ridged by deep parallel folds, produced by a habit which the condor has of so retracting its head when at rest as to give the impression that it has no neck. The beak of the condor is massive and strong, ash-colored and straight at its base, but sharply arched toward the point, where it terminates in a strong, well-curved hook of nearly ivory whiteness. The bluish-gray legs are extremely heavy and powerful. The toes terminate in black talons, which, though long and thick, are only slightly curved; the hinder toe, too, while somewhat more curved than the others, is wanting in strength, which renders the foot weaker in its power of grasping than that of any other bird of its order.

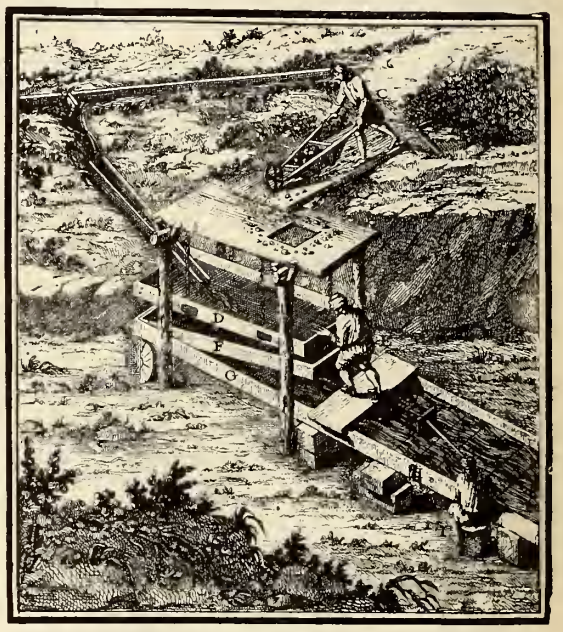
Laying aside the prejudice produced by its habits, we cannot but acknowledge that in appearance the condor, while heavier than the eagle, and less graceful in its movements when not upon the wing, is far from unattractive to the eye.—*Popular Science News.*

## THE GOLD DEPOSITS OF THE PYRENEES.

IN a very interesting work entitled *Les Pyrenees*, recently published by Mr. Eugene Trutat, the author, *apropos* of the varied mining wealth of our country, calls attention to the auriferous deposits found therein. The question is of a genuine geological interest.

While, in fact, we find gold commonly in the sand derived from the Ariege, the Salat and the Garonne, and while in the extent of country comprised between Campagnac and Averdun all the ravines and brooks that empty into the Ariege are auriferous, it has hitherto always been impossible for any one to find *in situ* the rock whence the precious metal is derived. And yet this gold is far from existing in negligible quantity. In fact, according to Mr. Pailhes, an observer of the last century, there have been found between Varilhes and Pamiers spangles, or small *pepitas* rather, weighing as many as fifteen grammes.

At present, however, it seems that the deposits are greatly impoverished, so that the gold washers, formerly numerous in the country, have almost completely disappeared.



GOLD WASHERS TREATING AURIFEROUS EARTH.

A, flume leading water to the riddle; B, platform upon which the earth is deposited; C, laborer bringing the earth; D, riddle for washing the earth; E, laborer actuating the riddle; G, washing table; H, table covered with cloth on which the washing of the earth is finished; I, laborer stirring the deposit on the cloth-covered table. (From an old engraving taken from Baron Dietrich's work.)

This industry of the gold washers, as it was carried on a century ago, while it was still flourishing, was, moreover, an interesting practice.

A writer of the time, Baron Dietrich, in his curious work entitled *Description des Getes de Minerai, des Forges et des Salines des Pyrenees*, published in 1786, has left us some precise data upon the various methods of treatment in use among the gold washers in the county of Foix in order to obtain spangles of gold.

"The first of the methods of the gold washers of Pamiers," says he, "is the most general. The second is employed only for the very fine spangles. Yet the use of it is unfortunately very rare.

"They make use of three instruments in the first method, to wit:

"(1) A shovel called *andusa*, 9½ inches in length by 7½ in width, having the edges turned up at the sides by about four lines. This shovel serves to remove the large pebbles that cover the finest gravel as well as the sand, which the washers dig into successively until they come upon a finer part intermingled with those masses of pebbles called the *balme*. This operation produces holes upon the banks. They employ the same shovel for putting this fine gravel and this sand into the *greffane* or *gressale*.

"(2) The *greffane* or *gressale*, a sort of wooden plate of a foot and six to nine inches in diameter, hollowed out in such a way that it has a depth of about three inches in the center. It is into this plate that they put the sand and pebbles together. The largest of these pebbles scarcely exceeds an egg in size, because they throw aside with the *andusa* those that are larger.

"The plate being filled with gravel and sand, the men go barefooted to a distance of a few feet in the river or brook.

"They begin by putting their plate under the water. With one hand they stir the earth contained in the plate and draw the pebbles toward them and out of the plate, which they hold with the other hand. This too prompt operation performed in the current of the river must necessarily allow the spangles of gold, which are very small, to be carried away with the earth. After they have separated the coarser earthy portions in this way, they raise their vessel to the surface of the water and leave a portion of water in it in order to cover the sand that remains therein. They give this water a rotary motion in slightly inclining the plate toward the river, so that the lightest portions are drawn toward the edges and the heaviest collect in the center. They finally strike the river several times with the inclined part of the plate. This, again, causes the heaviest parts to deposit and the lightest ones to be carried along by the water that the motion admits into and rejects from the plate. They decant the surplus water slowly in always giving a slight rotary motion. There remains in the center of the plate a gray, black and reddish quartzy sand, strongly attracted by the magnet, and containing spangles of gold distinctly visible and of varying size. Then they allow a stream of water to enter the plate, and this causes the washed auriferous sand to flow into the *scudelle*.

"(3) The *scudelle* is a small wooden bowl of the ordinary form of bowls, and about three and a half inches in diameter, into which is poured the washed sand at each of the operations just described, and when the sand is therein the water is drained off. The humidity of this sand causes it to fix itself to the bottom, so that these people put their little bowl entirely open into their pocket without the sand escaping from it.

"The second method of collecting gold in the county of Foix requires one machine more. The one that I have seen consists of a washing plank or table five feet four inches in length by about twenty to twenty-two inches in width, provided on each of its long sides with a rim eighteen lines in height. The two extremities have no rim.

"This table is divided in the direction of its length into two unequal parts by a strip of wood about eight lines in height, the base of which is well joined to the plank. The upper part is from nineteen to twenty inches, and the lower takes up the rest of the length of the plank. I say the upper, because the plank is inclined upon a support about twenty inches in height.

"Under the strip is tacked a sort of closely woven packing cloth that extends from the strip to the lower extremity of the plank, and there is attached also to the strip, over this cloth, a small bib of coarse wool about six inches in height that occupies the entire width of the table.

"The gravel and sand are put upon the upper part with the shovel or *andusa*, and water is poured thereon with the *greffane*. The sand is stirred up successively with the hands, and the largest spangles of gold deposit upon the bib and the finest upon the cloth. In either way, there is obtained a fine, heavy, black and reddish ferruginous and quartzy sand that contains the spangles. The gold washers treat this sand with mercury, of which they afterward evaporate the amalgam."

As may be judged from this minute description by Baron Dietrich, the processes of treatment in use among the gold washers of the county of Foix were passably primitive. In spite of the imperfections of the system, it did not prevent the trade from supporting its followers, although quite meagerly. "The washers sell these spangles at 80 francs per ounce. In ordinary times they earn from 20 to 30 sols a day; and, when the water has been high, their work brings them in currently 6 francs a day. This gold is from 22 to 23 carats fine."

The quantities of gold thus extracted by the washers of the Ariege were nevertheless quite large, and, if we refer to a memoir by Mr. Pailhes, we find that the mint of Toulouse received as many as 200 marcs of gold per annum from the washers of the Ariege, the Salat and the Garonne.

Besides, states Baron Dietrich, the places of production of the gold were quite numerous in the region of the Pyrenees.

"The Ariege and the grounds in its vicinity are not the only ones of the county of Foix from which gold is derived. The collecting of it is done in still a few other places; but this work is more neglected there than in the vicinity of Pamiers. The following are the principal of these places:

"The brook of Pailhes, near the market town of that name, situated on the route from Pamiers to Mas-d'Azile, at about 6,000 toises to the west of Pamiers.

"The brook of Beouze, near Bastide-de-Seron, on the route from Foix to Saint-Girons.

"The brook of Pitron, under the *metairie* of Mazeres or Mazelles, at about 1,300 toises to the east of Bastide.

"The brook of Harize, at Durban.

"The brook of Ordas, near Durban, at 1,700 toises to the north of Castelnan-Durban, a market town, situated upon the same route, at about 4,000 toises to the west of Bastide.

"And the brook of Saint Martin.

"I have had sand washed in all these brooks, and they have all furnished me with gold. They are all in the foot hills or mountains, distinguished in the country by the name of 'mountains of earth.' These brooks traverse all the deep and pebbly ravines. Quartz and ironstone are generally found therein.

"The majority of the observations made in this memoir are also applicable to the Salat.

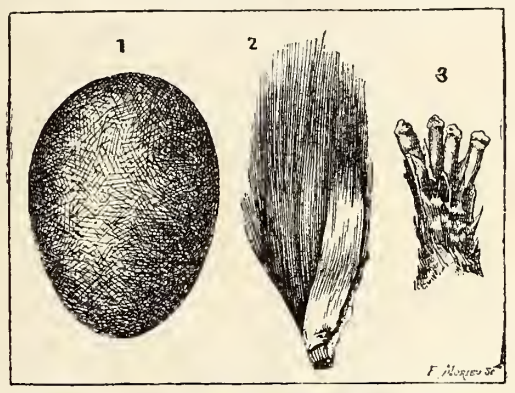
"Collecting is sometimes, but very rarely, done there on the Souex and Saint Serni side, at about 5,500 toises to the southeast of Saint Girons, in the brook of Nest, which empties into the Salat above Saint Girons, and to which the washers attribute in part the gold of the Salat. But the most ordinary work of the washers is done below Saint Girons, from Bonrepaux to Roquefort. It is principally women who occupy themselves with it in this part."

Such are the most precise data that we possess as to the exploitation, in the last century, of the auriferous deposits of our Pyreneean region.

Without being of a marked richness, these deposits, contrary to the present status of the case, fully merit being the object of a continuous exploitation.—*Les Inventions Nouvelles.*

## PILÆ MARINÆ.*

IT is not rare, on the seashore, amid the debris of all kinds thrown up by the tide, to meet with certain round, depressed or ovoid masses formed of light brown, very slender filaments so entangled and closely matted that they are capable of withstanding considerable pressure without being distorted. Their size varies from that of an egg to that of a human head. What is the nature of these singular productions? A few words of history will not be out of place. Galen and Aristotle recommend the balls under consideration for scrofula, but venture no theory as to their origin. Matthiolus and Cæsalpinus consider them as sea refuse. More recently the authors who have occupied themselves with the question, and among whom may be mentioned Imperato, Draparnaud and Bory Saint-Vincent, have been divided in opinion, some




*Pilæ Marinæ:* 1. Entire ball, much reduced. 2. Stock of *Posidonia* becoming filamentous under the influence of sea water. 3. Scales of a pine cone altered by sea water.

holding that these objects consist merely of entangled algæ, and others regarding them as *Zosteræ* in the process of decomposition. Others, finally, have looked upon them as having an origin analogous to those balls of hair that are found in the stomach of ruminants, and that are called ægagropilæ.†

Mr. W. Russell‡ has recently resumed the study of the question, and has elucidated it in a complete manner. The differences of opinion of authors are easily explained, for from one place to another, even very close by, the origin of the balls may be very different. In the Mediterranean region we find in abundance a completely submerged plant belonging to the genus *Posidonia*. When the sea has been very rough, a certain number of the plants become a prey to the waves and soon perish. The long, flat leaves remain firmly attached to the rhizome, but their parenchyma soon disappears and leaves free long duct filaments and fibers that become entangled with each other and give rise to balls that are of a somewhat loose consistency.

In most cases, these balls are produced by pine cones. "In the course of a botanical excursion to Sainte Marguerite Island," says Mr. Russell, "I was following on the southern shore a road laid out in the center of a pine forest that extends to nearly where the tide stops, when my attention was attracted by a mass of these enigmatical balls that was so large that it constituted a true embankment around a small cove shaded by great cluster pines lashed by the waves. Upon carefully examining this deposit, I soon discovered, in addition to balls similar to those mentioned above, a number of pine cones, some of them uninjured and others appearing as if they had been raveled out and carded. Among the latter, some had undergone modifications only in their scales, which were divided into numerous filaments that were still adherent to the as yet intact axis. The pine cones thus transformed had exactly the appearance of those large brushes known by the name of badgers. In other specimens the axis had shared the same fate as its appendages, and was reduced to its ligneous skeleton to which were still fixed a few filaments, the last remains of the scales." All the phases of the disorganization of the tissues can be followed under the microscope.

Finally, in certain cases, the balls consist of algæ belonging to the genus *Cladophora*, more or less mixed with foreign bodies. Balls of this kind are frequent in the lakes of Sweden.—*La Nature.*

* I. e., "Seaballs"; French, *Pilotes de Mer;* German, *Meerpilzen* or *Seeballe.*

† These ægagropilæ are produced by the hairs that ruminants swallow on licking themselves, and that accumulate in the stomach. Ancient medicine attributed wonderful properties to them.

‡ *Revue Generale de Botanique*, 1893.

## CHRYSANTHEMUM JOHN NOBLE.

THIS variety is one of the many excellent English seedlings shown by Mr. Robert Owen, Maidenhead, at the meeting of the Royal Horticultural Society, held on December 12. John Noble belongs to the incurved Japanese section, and the great breadth of its florets, its large size, and bold massive appearance, contribute to make it a distinct and desirable variety. In color, it is a dull chocolate crimson, and the reverse of the florets bronzy gold. It is a good illustration of the "fancy" of the day and of the skill of the cultivator, but it is hardly to be commended from an artistic point of view.—*The Gardeners' Chronicle.*

## HOW PLANTS FEED.

THE root has two offices—first, to fix the plant in the soil, and, secondly, to absorb nourishment. To this might be added that some plants also use the roots for storehouses of food on which they draw in later stages of their growth, as, for example, beets, mangels, carrots, and, indeed, most plants which live but two years. During the first year they accumulate nourishment in the root, most of which is expended in the production of seed in the second year; but this feature is not of general application. That the roots secure the plant in the soil is a self-evident truth which does not need demonstration. Nor is it necessary to prove that the roots are the medium through which the plants are nourished. The point is to know just how the food is absorbed by the roots—whether the entire root mass is engaged in this process or if it is confined to some special portions of the root, and in what condition the plant food must be in order to be available for assimilation by the roots.

It is comparatively easy to prove that plants live by drinking, rather than by eating, or, in other words, that they are fed by absorbing water which contains the necessary elements of nutrition in solution. In early times, before the science of botany was understood, some theorists believed that plants fed on small particles of soils, and that this was reason for the good results caused by thorough culture, since frequent stirring of the soil divided it into small particles, which were thus more readily swallowed and digested by the plant. This notion could, of course, not stand the light

CHRYSANTHEMUM JOHN NOBLE.

of investigation, since the roots had no mouths or openings anywhere through which even the smallest particles could pass. It was, on the other hand, evident that plants fed by some process of absorption, since a withered plant might be revived by merely putting its roots in cold water.

This is further proved by immersing the young, active roots of a plant in water in which some coloring material has been dissolved. The roots absorb the color, which shows itself throughout the tissue. Now, does this absorption take place through the ends of the roots or through the whole length of the root? Investigation has proved that it does neither the one nor the other. The tips of the roots, as has already been stated, consist of a compact mass of small, hardened cells, which are designed to pierce the soil when the root is elongated by growth. These cells are not suited for absorption. Nor do the older portions of the root, on which the outer covering has become thickened and leathery, take a prominent part in feeding the plant. This is proved by the fact that a plant having the older portions of the roots immersed in water, while the young growth is kept in the air, will wither almost as fast as if the plant was wholly exposed to the air.

The absorption of plant food must, therefore, take place wholly, or at least chiefly, through the young and tender portions of the root. A close examination further reveals the fact that the young growth of the roots is more or less covered with very fine fibrous appendages which have been called root hairs. These hairs are slender tubes, with very thin walls, and they constitute the real absorbing surface of the roots.

Many of these root hairs are so small that they cannot be seen with the aid of a microscope. They are simply projections of the outer cells of the root, just as the fingers project from a glove—that is, they do not have a partition at the base, but open directly into the cells. As the root grows older, this outer layer of cells becomes thickened and the root hairs disappear, and the cells lose absorbing power in proportion. This explains why the older portions of the roots, covered with a thickened epidermis or sort of bark, have but slight absorbing powers. At the close of the season of growth, when plant food is no longer in demand for the development of new tissue above ground, absorption ceases and the root hairs die. Even the newer portions of the root become covered with epidermis, and the plant becomes dormant until warm weather the following spring renews its vitality.

But how can this absorption occur? What is the reason that the newly formed tender cells of the roots, when they come in direct contact with the moisture in the soil, absorb this moisture, or, in other words, what force causes the moisture to enter the cells? The cause is a natural phenomenon which has not been satisfactorily explained. It is due to the force technically called "osmose," or diffusion of liquids through a membrane, and is defined as a "kind of molecular attraction allied to that of adhesion." This force is exhibited when two liquids of different densities are separated from each other by a thin animal or vegetable membrane. The two liquids then tend to mix or become diffused by passing through this membrane. Thus experimenters have proved that when a bladder is filled with brine and then immersed in a vessel of water, the water will pass through the bladder and cause it to become more distended, and even to force its contents to rise in a tube attached to the neck of the bladder, and at the same time the brine in the bladder will pass through the membrane and give a salt taste to the water. Now the absorption of water by the tender cell tissues takes place on the same principle.

The moisture in the soil in which the roots are bathed passes through the thin cell walls and rises in the tissues of the plant. That the absorptive power which this force gives rise to is very great, at least in some plants, is readily proved by direct observation. Everybody is familiar with the fact that maple sugar is made from the sap of a certain species of maple tree.

This sap is obtained by boring a hole in the tree through which it exudes in great quantities. Fruit growers are familiar with the fact that when a grape vine is pruned late in the spring, after the roots begin absorption, it "bleeds" freely from the wounds. The same may be seen in stumps of trees cut down early in the season and in many other cases. Such cases give abundant proof that the sap which flows from the wound so freely must be replaced by the liquid absorbed by the roots.

That the roots feed on the soil, as the common expression goes, is really not correct. They feed on water contained in the soil which holds certain substances in solution. What these substances are we shall see in a later paper. The presence or absence in the soil of these food materials makes the difference between a fertile and a sterile soil. The fertile lowlands along rivers and streams are fertile because they contain an abundance of this food material, and hilltops and barren sands lack fertility because the elements of plant food are present in but small amount. Now, the root growth depends largely upon the fertility of the soil. It has been observed that when roots reach a fertile spot they develop an enormous amount of feeders, that is, small tender rootlets, which can absorb this nourishment.

Any one can readily convince himself of this by noticing how enormously roots multiply in spots in the soil where a small mass of manure has been plowed under. It is frequently found to be penetrated through and through with a thread-like network of the fine white roots, while in the soil immediately surrounding such spot the roots may be but sparsely distributed. It has even been noted that when there are successive layers of fertility in the soil the roots will develop in these layers in the manner stated, whereas in the less fertile soil intervening there are but few roots to be found. It is for these reasons that in a fertile soil the roots do not usually reach so far, but are more uniformly distributed through the whole mass of the soil than is the case when the soil is less fertile. In poor, sandy soil, it is claimed that corn roots have been traced for a length of fifteen feet from the plant. Call it instinct or what we may, they seem to have the power to search for food, and when found they make the most of it by producing an abundance of absorbing surface. In like manner the roots of some plants apparently go in search of water. When the soil can be penetrated, alfalfa roots will thus grow to a great depth until the water table is reached, and it is a common observation that the roots of willows or other trees will follow a drain or sewer for long distances until an opening is found through which the water percolates, and entering this they will fill the drain, sometimes for many yards, with a mass of roots almost as solid as if it had been clamped in place.—*Prof. C. C. Georgeson, in Kansas Farmer.*

## COMPARATIVE VALUE OF MANURES FOR POTATOES.

THE importance of this subject is so great to the country that any facts bearing on the possible increase of the crop by ordinary means should be frequently brought before the public, for facts are of much more value than flights of fancy. Land is of such variety in composition, and manures produce such different results on different lands, that it is desirable to carry out experiments in as many districts as possible to test manures which have given good results in other places.

There are a great number of allotments in this district, and for the benefit of the holders and the district generally a committee was formed to carry out some experiments for testing certain manures for potato culture. Potatoes are extensively grown here, and some who have grown large quantities for many years and have observed the effects of different manures and the quantity of each constituent to be applied per acre with benefit, are now able to grow 10 and 11 tons per acre, and that not in the best land, the land costing 1*l.* 10*s.* per acre. One large grower told me he would apply more manure if he found it of benefit, but there is a limit in the amount of a crop, and the manure applied to produce it is a serious item. The largest crop at the least cost should be the aim of all cultivators, but this cannot be attained without long experience and careful observation in testing various compositions. With this object in view, experiments were carried out last summer. The idea was to obtain some of the poorest land to prove more clearly the value of the manure.

The land itself without manure produced about 6 tons 3 cwt. per acre. This was from several perches of land. Three varieties of potatoes were tested—Maincrop, Imperator and Schoolmaster. The last named was planted because it is usually much diseased, and it was intended to apply the remedy for disease in July, but this was not done. We had from two to four perches of land for each of the compositions planted with Maincrop potatoes, and this variety gave the best results. Fifty-four square perches were set out carefully in an open field. The chemical manures were weighed in correct proportion per acre, and each square numbered on a regular plan. The manures were all applied when planting at the end of April, with one exception, the nitrate of soda, half of which was put on when the moulding was done in June. This turned out to be the best of all.

The land was not plowed deep enough, the soil being quite hard a few inches from the surface, and when this was discovered operations could not be cancelled. This I consider was much against the experiments. All the men recognized the want of depth, and many spoke disparingly of the work, yet many of the squares produced from 140 to 173 lb. of potatoes. We had seven rows in the perch, 16 feet 6 inches wide, and the potatoes about 15 inches apart in the row. The preparation of this land is what I should call bad farming, and there is little doubt that much land is not cultivated deep enough for this crop. I am aware that much land used for potatoes cannot be deeply cultivated, but there is much that could be, and it would pay for doing, even supposing only half of an acre could be plowed in a day. The following shows the manure used and the results obtained:

Farmyard or fold manure, 4 cwt. per perch, or 32 tons per acre, at 5*s.* per ton, would cost 8*l.* per acre. This produced an average of 120 lb. per perch; in round numbers this would be at the rate of 8 tons 11½ cwt. per acre.

Farmyard manure at the rate of 2 cwt. per perch, or 16 tons per acre, with superphosphate, kainit, and nitrate of soda in equal quantities, 4½ lb. per perch, or 6 cwt. chemicals per acre, produced on an average 138 lb. per perch, or 9 tons 17 cwt. per acre. Cost of manure 6*l.* 5*s.*

Chemical manure: Kainit, superphosphate, and nitrate of soda, 3 lb. of each per perch, or about 12 cwt. per acre, all applied at the time of planting, cost £3 per acre. This produced 142 lb. per perch, or over 10 tons per acre. The same manure, with this exception, that half the nitrate of soda was applied in June when the moulding was done, produced on an average 156 lb. of tubers per perch. This would be more than 11 tons per acre. The latter proportion of manures produced the best results at Warminster last year, and should be tried everywhere.

Six pounds per perch, or 8 cwt. per acre, consisting of 1½ parts superphosphate, 1 nitrate potash, 1 gypsum, cost £2 12*s.* per acre, and produced an average of 140 lb per perch, or 10 tons per acre. This is very good for such a cheap manure.

Six pounds per perch, of a mixture of 5 parts kainit, 4 nitrate soda, and 2 gypsum, cost £1 19*s.* per acre, and produced an average of 138 lb. of good tubers per perch.

Six pounds per perch, containing equal parts superphosphate, kainit, and sulphate of ammonia, cost £2 10*s.* 8*d.* per acre, and produced an average of 128½ lb. per perch.

Nine pounds per perch, consisting of 3 lb. superphosphate, 6 lb. kainit, produced 144 lb. per perch, at a cost of £1 8*s.* per acre.

Six pounds of manure per perch, containing 4 parts superphosphate, 3 nitrate of potash, 1 nitrate of soda, and 2 gypsum, cost at the rate of £3 per acre, and produced on an average 130½ lb. per perch.

Five and seven-eighths pounds per perch, consisting of 3 parts basic phosphate, 5 nitrate of potash, 6 gypsum, and costing 2*l.* 10*s.* 2*d.* per acre, produced an average of 117 lb. per perch.

Six pounds per perch, containing 2 lb. superphosphate, 3 lb. kainit and 1 lb. nitrate of soda, costing 1*l.* 9*s.* 4*d.* per acre, gave 144 lb. produce per perch.

Two and a quarter pounds of Ichaboe guano, per perch, at 1*l.* 17*s.* 6*d.* per acre, seemed useless.

Small potatoes were from 4 to 16 lb. per perch. The largest quantities, which were more than double of some of the least, had not half so many small ones, thus showing that good manure is profitable in every way. The chemical manures, which gave the best results, showed the good effect of the manure from the first, when the shaws were only a foot high. This was on the next section to that where no manure had been given, and every potato showed a marked difference. The Maincrop potato is of a splendid quality from suitable land, and is now the leading kind grown for the market. It is worth 10*s.* per ton more than the Bruce, but a ton per acre extra can be grown of the latter; it has yielded 11 tons to the acre this season in this district.—*George Harris, in The Gardeners' Magazine.*


THE

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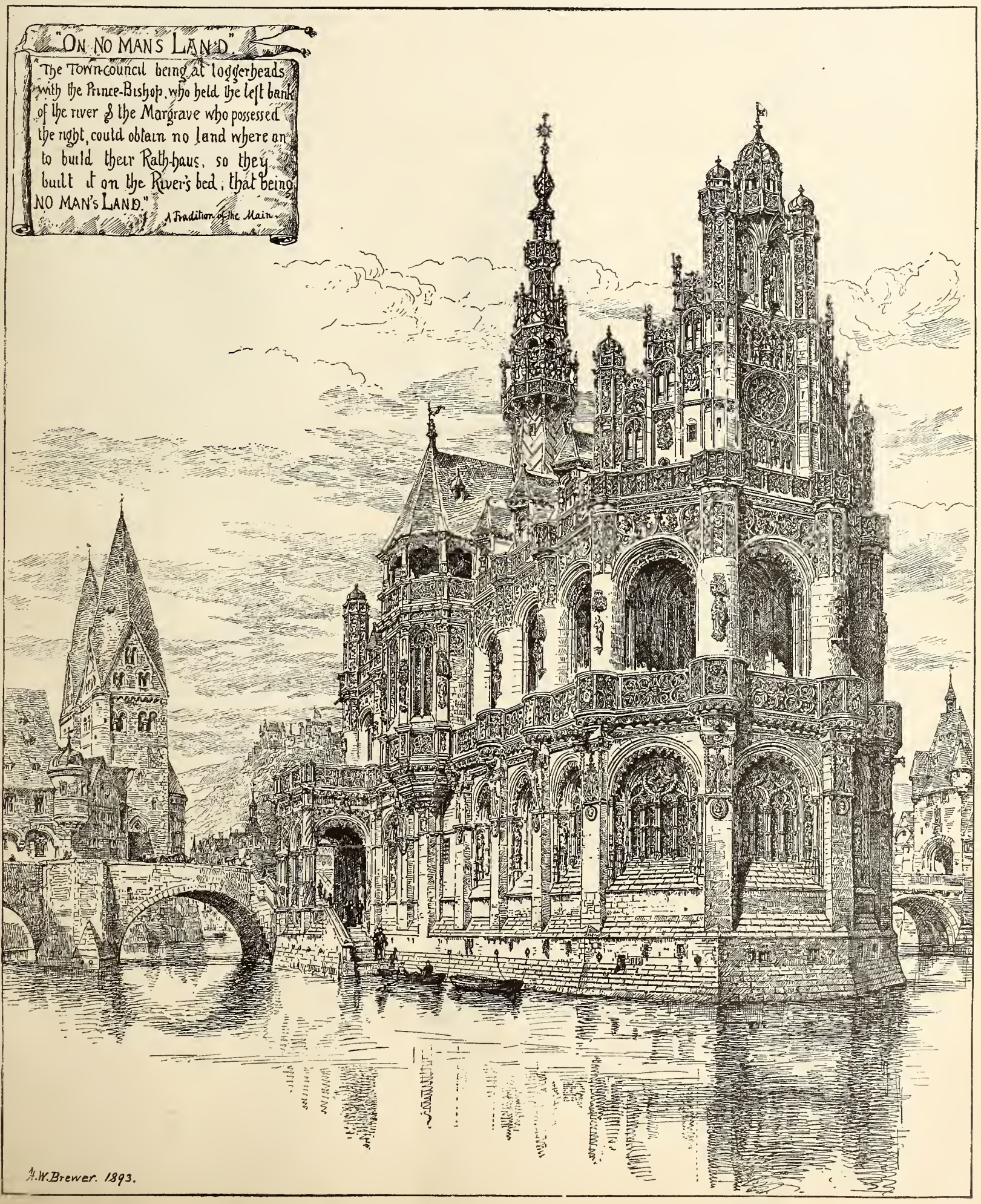
## THE RATHHAUS AT BAMBERG.

SOME of the towns and villages upon the banks of the Main have their Rathhauses erected upon most singular sites. That of Dettelbach, which has been previously illustrated in the *Builder*, stands upon an arch spanning a stream, and has the principal street of the town passing beneath it at right angles to the river. The Rathhaus at Marktbreit stands upon a bridge thrown across the city moat, and has a street passing beneath it. The Rathhaus at Bamberg has a still more remarkable site, as it is built upon the bed of the river, and tradition asserts that this singular site was selected because the town council, being on bad terms with the Prince Bishop, who held one bank of


"ON NO MAN'S LAND".
"The Town-council being at loggerheads with the Prince-Bishop, who held the left bank of the river & the Margrave who possessed the right, could obtain no land where on to build their Rath-haus, so they built it on the River's bed; that being NO MAN'S LAND."
A Tradition of the Main.
A.W. Brewer. 1893.

THE RATHHAUS AT BAMBERG, ON "NO MAN'S LAND."

river, and the nobleman who possessed the other bank, could obtain no land whereon to build the Rathhaus, so they erected it upon the river's bed, that being regarded as "*no man's land.*" Whether the tradition is true or not, we have been unable to ascertain, but the singularity of the site selected has not been explained by any other theory.

Unfortunately the Bamberg Rathhaus was entirely rebuilt at the close of the seventeenth century. The present building is consequently in the Late Renaissance style, covered externally with somewhat rank paintings in distemper. The general effect is not unpicturesque, but there is nothing about it to account for its strange situation. In the old view of Bamberg, given in the *Nuremberg Chronicle*, a building that seems intended for the Rathhaus has projecting parapets and corbeled-out turrets at the angles; in other words, it is a fortified structure, which is somewhat strange, because the town itself was never either fortified or walled round, an omission which is accounted for, it is said, by the fact that Bamberg was regarded as a sacred city from the great relic of the true cross deposited in the cathedral by the Emperor and Empress, St. Henry and St. Cunigunda, who are buried in the cathedral; and now comes a question —Is it not possible (supposing this fortified building shown in the *Nuremberg Chronicle* to have been the Rathhaus) that it may have been erected on the bed of the river for the sake of its protection? Because, although possibly the warlike barons of the middle ages may have scrupled at robbing a church protected by so sacred a palladium, yet they may not have considered that this protection extended to the treasure chest of the town council. However, although we venture to suggest this explanation, we must acknowledge that it does not meet one objection, and that is, it completely fails to account for the almost equally singular site in such towns as Dettelbach and Marktbreit, which were fortified, and could not claim immunity from siege and sacking on account of any unusual sacredness.

Our illustration represents a town hall erected on a similar site to that at Bamberg. It is, however, purely an imaginary design, and is not founded upon any existing building, or any structure of former times. The site being the center of the river, the general outline has been treated in such a way as to bear some resemblance to a ship with its lofty poop rearing itself out of the water. As at Bamberg, the approach is from the center of the bridge, and the building has an open loggia round the upper story, a feature very common in the mediæval Rathhauses of Germany, good examples of which are to be seen at Brunswick and Hildesheim. For our engraving and the foregoing particulars we are indebted to *The Builder*.

[From the Builder.]

## WESTMINSTER ABBEY.

To do full justice to the subject within the limits of a single article such as this would be impossible; but we may endeavor here to give an outline of its history, combined with some critical considerations as to its architectural qualities.

The period when Westminster Abbey was originally built is lost in remote antiquity; and the foundation which history fails to record is still further obscured by fabulous tradition. Thus we are told that when the first church was erected here on a small island in the midst of a marsh known by the name of Thorney, the fabric was consecrated by St. Peter in person, who was ferried over from the Surrey side of the Thames for the purpose. The site originally is likely enough to have been as described, for the configuration of the ground and its low-lying position bear testimony to its probability. The name, too, indicates a minster to the west, doubtless, of the Cathedral of St. Paul; and the dedication to St. Peter appears to point to a designed connection between the two evangelists. King Sebert, who founded the one, is credited with the erection of the other, and the record is reasonable. But his was not the first building on this site at least. Roman bricks were found within the area of the present abbey church when the grave of Geo. Edmund Street was dug, and although they may have been simply old material brought from the ruins of Roman London or from some building nearer at hand, yet they may have formed part of some fabric erected on the spot. But doubt as to this becomes reality by the evidence of a recent discovery which has not yet been recorded. When the grave for Lord Lawrence was dug, Mr. Wright, the clerk of the works, found a portion of a Roman wall *in situ;* and a fragment of a tile with a pattern on it, and some red mortar formed with pounded brick, are preserved in his office. There is nothing to show the nature of the building, only that it was of Roman date. The Roman sarcophagus, which will be referred to later, was doubtless brought from elsewhere. But its position, when found, in relation to some building, points to the previous existence of a church on the same spot, at least as ancient as the stone cross lid which covers it. After enlargement by King Offa, the early buildings passed through the ordeal of ravages by the Danes, in common with so many others throughout England, the exposed position outside the shelter of the walls of London doubtless contributing to their fate. King Edgar restored them, and we hear of there being but twelve monks established there in his time.

We are on certain ground when we come to the days of King Edward the Confessor, whose palace, adjoining the monastery, on the banks of the Thames, has occupied so important a place in the history of our country to the present day. The rebuilding of the Abbey and its attendant buildings was begun and continued on an extensive scale. The new charter granted to the monks confirmed to them all their previous endowments, with many additions, and mention was made not only of the original consecration by St. Peter, but of the ravages made by the Danes. The church was consecrated in the most impressive manner, in the presence of a vast assembly, nobles and bishops having been summoned to be present from all parts of England. It occurred on the Feast of the Holy Innocents, December 18, 1065, and but a few days before the death of the king, who thus had the gratification of seeing the completion of that portion of the work which he had founded. The buildings erected by him mark a clear and defined epoch in the history of our national architecture, and on this account it is impossible to devote too much attention to the consideration of the remains, all too few and unimportant, unfortunately, that actually exist. These may be traced without much difficulty among the mass of superb Gothic work of later date, but the parts that remain are of the monastic buildings only, with one important exception, and the most elaborate parts have disappeared. Fortunately, the ground plan of the Abbey enables us to infer with fair probability as to the extent of the confessor's foundation, and, in addition, the documentary evidences are important and more or less reliable. As is well known, the buildings are described as having been erected in a mode of construction not then usual in England, and the "costly expenditure" spoken of by William of Malmesbury and Matthew Paris alike is amply attested by the large area of ground which they covered. Water was laid on to the Abbey from a spring at the southern end of the present Serpentine in Hyde Park, where a tablet still attests the fact. Large and extensive drains, which in recent years have been mistaken for subterranean passages, still exist in many directions, showing that the sanitary arrangements of the establishment were on an extensive scale. The bulk of these drains, which are formed of masonry, are still in use, and their size affords easy reason for the belief that they were secret passages, while tradition affirms that one actually exists beneath the Thames, affording communication with Lambeth Palace!

Sir Gilbert Scott, in his "Gleanings from Westminster Abbey," quotes from the lives of Edward the Confessor, written between the years 1065 and 1074, wherein the church is described as being raised high, vaulted, with square and uniform ribs, circular to the east, double vaulting to the aisles, of two stories, the cross building contrived to contain the choir in the middle, and to support the lofty tower, which, we are told, had a timber roof covered with lead. A description, somewhat similar, written in Norman-French, during the reign of Henry III., just prior to the rebuilding, speaks of the church having been built with large, square blocks of gray stone. The central tower is again spoken of, as well as the round east end, and two towers at the west front are named. Also a chapter house, toward the east, vaulted and round; bells, sculptured stones, and storied windows. These descriptions, if exact and reliable, would indicate that the confessor's church must have been a fabric conceived on much the same scale, although not the same design, as the Abbaye aux Hommes at Caen, and it may be, with some features which were only added to the latter building at a later date. We are not left to merely written description. The view of the church in the Bayeux tapestry indicates a building which corresponds fairly well with these descriptions, and it is remarkable for the loftiness of its central tower, which exceeds in the lightness of its proportions anything of Norman date that exists. In fact, the whole design may afford evidence that Norman architecture was not remarkable for heaviness of form when the fabric was relieved by high pitched roofs, steeples, and picturesque terminations. It may be remembered that the very truthful picture of Canterbury Cathedral, eighty or ninety years or so later than the date of the building under review, affords precisely similar evidence. Whether or not Edward the Confessor really completed the church is open to much conjecture. The extent of the undertaking and the shortness of the time would appear to render this very improbable. It is true that, as we have seen, the narrative speaks of the two western towers, and the Bayeux tapestry view shows a completed nave; but this may have been an anticipation of what was intended or imagined, rather than a record of fact. Mr. Micklethwaite, in his restored plan of the church at the early Norman period, adopts the view that the confessor's church only included the choir, the crossing, the eastern bay of the nave, the cloisters, and the southern nave wall, or its lower portion, as far as the northern cloister walk extended. Following the analogy of almost every other church, it may reasonably be supposed that the work was begun at the east end, leaving the completion of the western portion to a later time. The confessor having been buried so soon after the consecration (in front of the high altar) indicates distinctly that the choir, at any rate, was completed. The central tower, too, would require the transepts for abutments, and some portion, at least, of the nave for a similar reason.

Be this as it may, and recognizing the fact that the documentary evidence, which has been briefly referred to, is in favor of the entire completion of the church by the confessor, the belief that it was otherwise can only be reconciled to the evidences by the supposition that the nave was finished soon after the consecration. All the documents refer to a completed building. Beyond additions to the monastic buildings made in times following the Norman conquest, partly referred to in documents, but more clearly indicated by the surer test of the architectural detail, no alteration appears to have been effected in the Abbey church. The Infirmary chapel dated from the end of the century following the conquest. But the thirteenth century witnessed great changes in the forms of our Norman minsters, partly necessitated by badness of workmanship and hasty construction, but still more so by the love of change, which in old times as well as now may have operated badly for the preservation of ancient work.

We hear of the erection of a lady chapel in 1220, an addition doubtless at the east end of the circular aisle inclosing the presbytery. This was speedily followed by the demolition of the entire east end, as far as might be necessary, to make way for the magnificent fabric which still exists, the pride and boast of our country. The entire east end (except Henry VII.'s chapel), with its ambulatory and radiating chapels, the transepts and their double aisles, the Chapter House and the first bay of the nave, date from 1220 to 1260, the work having been begun at the east and extended to the west, the portion of the nave being necessary for the support of the slender piers of the crossing, and to carry the work to a uniform line from north to south. The next few years witnessed an extension of the work of rebuilding the nave. Four more bays were completed, and then the remainder was left, most probably joined more or less well to the Norman portion not yet removed, although the walls of the new aisles were erected in anticipation of the entire rebuilding.

Mr. Micklethwaite regards these four bays of the nave as also the work of Henry III., though executed later than the eastern bay of the nave. His reasons for this conclusion, which is a little at variance with the hitherto received dates, were stated in a paper read a few months ago at the London meeting of the Archæological Institute.

The four bays in question have commonly been referred to Edward I. Mr. Micklethwaite admits that the portion undoubtedly attributed to Henry III. (up to the first eastern bay of the nave) must have been finished before the other four bays were commenced; but he points out that the treatment in the latter is essentially exactly the same as in the eastern bay; that the differences are only so slight as might have been expected to occur in the recommencement of the work after a very short interval, perhaps with a new set of builders, and with a desire to make slight improvements on the previous work; the plan of the piers is improved, bronze bands are used with the shafts instead of marble, and there is a better treatment of the spandrels of the wall arcades; but the whole feeling of the work is the same. An examination of the building in reference to this theory convinces us that there is at all events great probability in favor of his view, and we have therefore adopted it. The nave remained in its incomplete state until well into the fourteenth century, when the clearstory and the vaulting were finished, and the long line of the nave roof was perfect from end to end. The west front, the central door and the two towers remained incomplete, and although the early years of the sixteenth century witnessed the completion of the doorway, etc., the towers remained only at about one-half of their present height, with no gable to the front, until the time when the western facade was completed, either by Wren or his pupil Hawksmoor, for there seems no positive certainty to which of these two architects the work is to be credited.

Old views of the abbey are not uncommon which show the appearance of the fabric without the towers. Among these, those of Hollars are supposed to be the most truthful, though we have great doubts whether he merits the reputation for accuracy commonly accorded to him. His northern view indicates how completely the fine portal of the north transept was hidden by a large gabled porch of late date, removed in the last century. Other views indicate a lofty and thin spire, once intended over the crossing, which, fortunately, was never erected. Henry VII.'s chapel, with its delicate and intricate work, stands on the site of the old lady chapel of Henry III.'s time, and may be considered as the last addition made to the abbey before the dissolution. Its erection has been followed by a long series of small remodelings and substitutions of new work for old, to the interior as well as the exterior, and it may be said that the scaffolding is never entirely away from the fabric, so large is its extent and so costly to keep in repair.

On entering Westminster Abbey, the first impression of a visitor conversant with our English cathedrals must be, in regard to its unusual proportions. The beauty of the groined roof may be probably equaled, the length may be exceeded, but the great height in relation to the width, and its attendant beauty, is not seen elsewhere in England. The spectator feels he is in a cathedral of the north of France rather than in an English one, until he observes the familiar forms of the detail which is the counterpart of work of the same date in our own country, only wrought in the most elaborate manner. Here is beautiful foliage, boldly undercut and admirably worked, rich moulded arches, polished Purbeck marble, shafted in profusion, and all the other items of detail which distinguish English work from French. The impression of foreign design, derived from the unusual height, is confirmed when the ground plan of the east end is considered. While previous minsters in England had, at most, a few semicircular chapels radiating from the curved ambulatory, or aisle, surrounding the presbytery, as at Norwich and some few others, here, instead, are six half-octagonal chapels, while the space of a seventh, the lady chapel of 1220, occupied the central position. The lines of their setting out are perfect, and the difficult problem of their arrangement, which can be studied in its development from the commencement to its perfection in the earlier French examples, is here found in its most complete form. The general resemblance to the east ends of Amiens and Reims cathedrals, if the plans be compared, will at once be apparent. On the north side, the square projection now known as Islip's chapel, and that of St. Benedict's on the south side, are suggestive of slender steeples, such as we see in the choir of the Abbaye aux Hommes, or those which once existed at Canterbury.

Within the presbytery, west of the modern face of the screen, buried beneath the superb mosaic pavement, are the bases of two of the piers of Edward the Confessor's church.

They are of plain Norman form, very similar to the somewhat later work at Winchester and elsewhere. They are valuable as being the only known fragments yet met with of the destroyed building, and they indicate not only that the center line of the existing church was the same as the former one, but also that the latter is wider. The Gothic building could, in fact, have been erected around and over the older one, so far as regards the central portion.

The pavement before the screen deserves special attention as being Italian Opus Alexandrinum, formed of rare marbles, derived most probably from the ruins of ancient Rome, mingled with our own Purbeck marble, and laid in a pattern which is completely mediæval Roman. There is another mosaic floor of plainer design in the space behind the screen, so well known as Edward the Confessor's chapel. It will be noticed that, while the mosaics of the pavements are of porphyry and marbles, those of the tomb of Henry III. and in the shrine of the confessor, where they remain, are of glass.

A small portion of the decoration of the celebrated coronation chair is of the same material. The importance of these art works, it may be remembered, is enhanced from the fact that, apart from the value of the design, there is but one other pavement of Opus Alexandrinum in England—that at Canterbury, where, however, the design is totally different; and no example at all of glass mosaic is extant except a small portion of an ancient Roman pavement at Aldborough. The

detail of the screen, the eastern side being ancient, of fifteenth-century work, illustrates incidents in the life of the confessor.

The transepts have double aisles, the arches being of acute lancet form. The former rose window of the north transept, lately replaced by a new one, was of fifteenth-century design, which it would have been a pity to remove, but that it was a copy executed early in the last century, and found to be all to pieces when the recent recasting of the front took place. The stained glass which then filled it has been replaced, but with the absurd alternation of cutting off the feet of the figures to make them fit the new tracery, which was apparently designed without any intention of preserving the old glass, although it is a good specimen of glass painting of the last century, when such works were hardly ever executed.

The nave presents a curious study of Gothic details of more than usual interest, from the fact that while the general design of the whole is similar in the early and the later parts, which harmonize well in this respect, yet the detail in each case indicates the varying periods of the execution, and the junction at the point where the works of the two periods meet is worthy of observation. The wall arcades have been of great beauty, but are now much cut into for the insertion of modern monuments.

In the space beneath the southwest tower, inclosed by a fifteenth-century stone screen, is deposited the old font of the abbey of the same date, and the window over it, as well as the corresponding one of the sister tower, is filled with contemporary stained glass. The clearstory windows of the east end are also filled with old stained glass. The pavements are mostly modern, but several specimens of encaustic tiling remain in the chapels, while the chapter house has a pavement all but perfect except for wear.

At the south end of the western walk of the cloisters an ancient arched recess is now being opened, and a mass of elaborately worked late Norman detail, built in as old material, has been discovered. A good many pieces of similar stonework have been found in recent years. Elsewhere are deposited various interesting fragments of stonework, including a Norman shaft of later date than the confessor's time—probably from the former cloisters.

Passing over many curious features of the monastic use of the cloisters, it will be noticed that the western aisle of the south transept is carried above their eastern portion. A reference to the ground plan, and some irregularities of line,* furnish some evidence of interest relative to the size of the confessor's church. Here the rebuilding joined the early work, and it is apparent that the existence of the east walk of the cloister rendered it imperative to modify the new aisle in the way named. The south wall of the south walk is the ancient north wall of the confessor's refectory, the masonry of which is here and there visible. The southern limit of the confessor's cloister is thus determined, while the northern limit was the wall of the south aisle of the nave. One of the sides being thus determined, these considerations render it almost a certainty that his cloisters were of the same size as at present. Entering from the east walk, the superb double arch of the vestibule of the chapter house, on which traces of color decoration are still visible, is passed, and the chapter house is reached. This beautiful apartment, with its restored vaulting and windows, is a good example of Sir G. G. Scott's genius in "restoration," here exercised with better reason and happier result than in some other instances; its ancient wall paintings are of much interest, and all can be studied with advantage. Its present beauty is in marked contrast with the appearance indicated by not very old views, which show it shorn of its window tracery and vaulting, and filled with shelves and presses wherein were stored the records of England. Bad as are the acoustic properties, it is matter of surprise how the early parliaments managed to get through their work within it. Perhaps the debates were shortened in consequence. To the south, the confessor's work is very apparent, and in the carefully locked chapel of the Pyx, the plain cylinder shafts, with their semicircular arches and vaulting, still remain. Although entrance is generally impossible, a bay or two of similar work is capable of being inspected at the southern end, and it will be noted that an attempt has been made to decorate the plain caps with sculpture at a later Norman period. The extent to which this practice was indulged in throughout England, and the manner in which early Norman work has been made to resemble that of later date, has not even yet been fully recognized. It will be noted that the confessor's masons have invariably worked their stones with diagonal tool marks, such as exist equally in work after the conquest. Over the range of vaults, which were formerly the monks' day room, is the long gallery now used as Westminster school, formerly the monastic dormitory. The walls are, for the most part, of the confessor's date, and at intervals a window or two may be inspected. One was laid open for inspection, in perfect condition, when the class rooms of Ashburnham House were erected in 1883. It was wide for its height, the arch stones and jambs being of Caen stone, the favorite freestone which is used throughout the early work; the stones were sawn, but the arch stones were not truly worked, and the setting had to be accomplished by wide joints. All the freestone is set with very wide joints; those to some of the cloister stones measure 1⅛ in. in thickness. When the works referred to were carried out, a series of seven closets of the necessarium were found built above one of the sewers already referred to. The range had extended, apparently, beyond Inigo Jones' Ashburnham House. Below, part of the Misericorde was met with, and traces of inscriptions scribbled on the walls in idle moments remained; one of these, in black letter, having reference to a certain pie, referred to some good cheer of long past days.

Above, on the first floor, close to the closets, a mediæval fireplace was found, with a comfortable arrangement of the hob, which enabled some creature comfort to be kept warm when wanted. Some three or four others have been found elsewhere from time to time. These curious relics of the past were all cleared away for the new works, as were also some traces of ovens, which were laid open for a short time at the southwest angle of Ashburnham House. They were formed of thin tiles. It is of the more importance to place their discovery on record, since they were seen by but few people at the time, and the position of the abbey kitchen has been the subject of discussion.

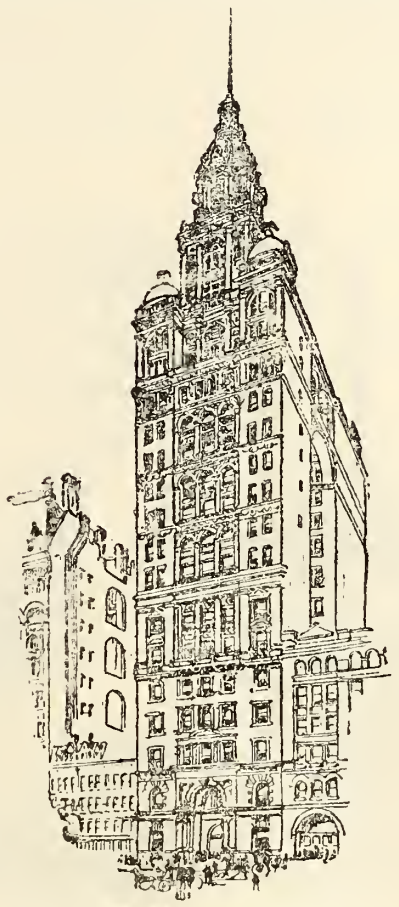
It may be added that the western gable of Ashburnham House is ancient, and it is evidently an external wall.

*(To be continued.)*

* A word of comment is required here. It will be observed that Mr. Micklethwaite's restored plan shows the lines of the cloisters very much askew, and on the lithograph plan, based mainly on a careful plan prepared some years ago by Mr. R. Phene Spiers, no such distortion is visible, though the western walk of the cloister is shown a little out of square with the nave wall, trending toward the west as it recedes from the church, and this, as far as we can judge, is correct; at least, if there is any deviation from the right angle here, it can hardly be more than that. Mr. Micklethwaite believes (as is indeed most probable) that the lines of the present cloister follow those of the confessor's cloister; but, if so, he has certainly exaggerated the skew element on his plan. On the other hand, there is a perceptible bend westward in the line of the east walk of the cloister, at the point where it leaves the angle of the transept, as any one may see by standing at the transept door and looking along the cloister aisle southward; the bend here is as decided a deviation from the rectangle as Mr. Micklethwaite's plan shows, but this deviation is only, as far as the eye can judge, in this portion of the east cloister walk. But the fact is that the various slight deviations of line in a great mediæval building like this, built and added to at various periods, could only be realized with absolute accuracy by a survey with the theodolite, a piece of work we could hardly have undertaken, even if the authorities of the abbey could have found it convenient to permit it. But we decline to believe, on the evidence of our eyesight (including a bird's eye study of the cloister garth from the roof of the nave aisle), that the present cloister is as much askew as the ancient one is shown on Mr. Micklethwaite's plan.

## HIGH BUILDINGS.

THE evolution now going on in the method of constructing city office buildings is very interesting. The

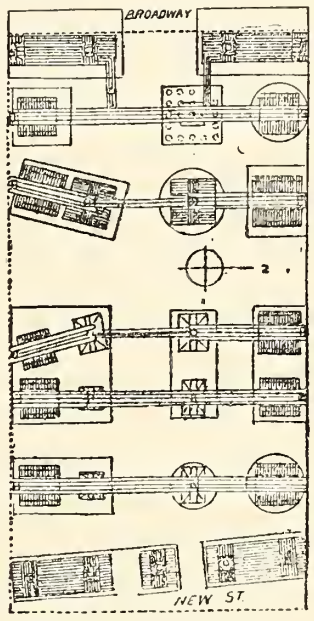


THE NEW MANHATTAN LIFE INSURANCE BUILDING.

rapidly growing value of real estate in business centers made it necessary to increase the height of the buildings. The old materials, stone or brick, put a natural limit to the height to which it was economical to build, as the necessarily thick walls of very high buildings occupied too much floor space in the lower stories. Within the last few years the cheap production of iron and steel has brought about their employment for the main supporting members of buildings, and at one stride the practicable and economical height of office buildings has been increased to two or three times that of buildings constructed in the old way. The new method, called the skeleton frame construction, reduces the use of brick and masonry to a mere covering shell. The masonry of each story is supported on steel beams framed between columns, permitting such thin walls, even at the base, as not materially to encroach on the available space.

One of the features of this evolution has been to concentrate the weight of the buildings at the isolated points from which the columns rise, instead of distributing it over a large continuous area, as the walls of the old buildings do. This concentration calls absolutely for a different style of foundation. Where it is attempted to carry heavy loads on the outer edges of a building the tendency is to cause settlement and consequent cracking. The solution of the problem is either to carry the weight from the edges back to the centers of the foundations by means of lever beams or cantilevers, or to carry the concentrated loads down to rock or some other unyielding material. The necessity of doing this is augmented by the fact that it is not sufficient simply to get an adequate foundation for a building, but it is necessary also to guard against danger from adjacent excavations in the future. The material beneath buildings is now often under such pressure that it will eagerly seek an escape laterally when an excavation is made alongside.

A notable example of the new method of construction is the building of the Manhattan Life Insurance Company in Broadway, near New Street. The weight of the building is estimated at 21,600 tons, or a little more than 43,000,000 pounds, to which must be added 2,400 tons, the pressure exerted upon the foundations owing to the force of the wind acting upon the sides of the building and trying to overturn it. The weight due to human beings and furniture is put at 7,000 tons, giving a total of 31,000 tons, or 62,000,000 pounds, to be sustained by the foundations. This enormous weight could not be carried safely on the natural soil, which consists mainly of mud and water-bearing sand overlying the bed rock. The latter has a fairly level surface about fifty-four feet below Broadway. If piles

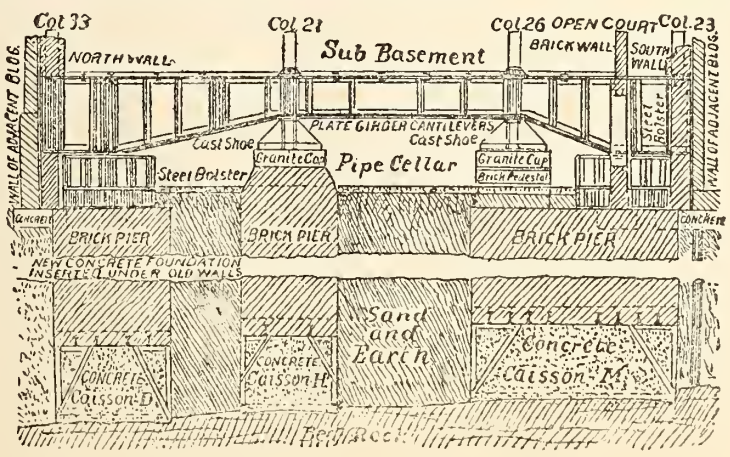



THE GROUND PLAN.

had been driven all over the 8,170 square feet of the building lot as close together as the law permits—that is, thirty inches between centers of piles—a little more than 1,300 could have been used. This would have given an average load per pile of 47,000 pounds, or 7,000 pounds more than the building laws allow. A pile foundation was, therefore, not possible, and it might have been dangerous in the case of future excavations alongside. The nature of the soil made it impracticable to reach rock by means of an open excavation, especially in view of the heavy buildings adjoining. The pneumatic process was, therefore, employed to carry the foundations down to bed rock, and it enabled the architects to reach the rock without disturbing in any way the material except in a volume equal to that of the caisson. The pneumatic method, which has long been used in sinking foundations for bridge piers, had never been employed in building construction, and the credit for the adaptation of the process belongs to the architects of the building.

A caisson consists of an inverted box. In this box air pressure is maintained equal to or slightly above the pressure of the water, so that it is impossible for any water to enter. Excavation is carried on by laborers in the caisson, which sinks gradually down as the excavation advances. Masonry on top of the caisson is built up as the caisson goes down.

The caissons of the Manhattan building are of steel. The working chambers were eight feet high, and brilliantly lighted by electric incandescent lamps. The average rate of sinking was four feet a day, and generally about eight days were required to sink each caisson. After the lower edge of the working chamber had reached bed rock the rock was cleaned and leveled inside of the chamber. The chamber was then filled with concrete, and the caisson and the pillar of brick ma-




CROSS SECTION OF FOUNDATION.

sonry on top became like an excrescence of the natural rock, hard and unyielding like it.

Fifteen caissons are used for the Manhattan building, of which four are cylindrical, with diameters from 10 feet to 15 feet, and eleven are rectangular in plan. The largest one of the latter is 21½ feet by 25½ feet. The first caisson was delivered at the site April 13, 1893, and the last pier was completed August 13, 1893. The piers cost nearly $150,000 in all, or about 10 per cent. of the total cost.

The building has a frontage on Broadway of 67 feet. Its depth is 119 feet on the north line and 125 feet on the south line. The building proper is to have seventeen stories on the Broadway front and eighteen stories on the New Street front. It will be 242 feet high from the Broadway sidewalk to the top of the main roof. Rising from the main roof on the Broadway front there will be a tower, which will make the height of the building from the Broadway curbstone to the foot of the flagstaff 350 feet, or 70 feet more than the steeple of Trinity church.

The proper design of the steel construction was a matter of first importance, on account of the weight and the height of the building. The element of height made the influence of the wind a very important factor. The total weight of the building, with the exception of the front wall on Broadway, is carried on thirty-four columns. Of these columns thirty-two are of cast iron up to the fifth floor level, and of steel above this elevation. The other two columns are of steel throughout. Between the columns are framed heavy steel beams, which, in their turn, support smaller beams, between which flat arches are sprung, forming thus the floors. Careful attention has been given to the fireproofing of the building, each exposed surface of a column or beam being covered by a thickness of four inches of tile. Experience shows that unprotected iron will crack or bend under fire. The Broadway wall supports its own weight, but is anchored into the steel frame for lateral support. It is nearly six feet thick in the basement, and is of granite up to the first floor level, as the pressure per square foot exceeded that which the building laws allow for limestone, of which the rest of the wall was built.

The building has been designed to withstand a wind pressure of thirty pounds per square foot against its entire surface. To illustrate this force, it may be mentioned that such a pressure would blow an empty passenger car off the track. The wind pressure against the long sides of the building will be sustained by the solid front and rear walls. If the wind blows against the ends of the building, it will be resisted by the brick party walls, which run continuously from Broadway to New Street up to the sixth floor level. The southern side of the house is broken by an open court above this elevation, and the wind pressure against the upper stories is taken care of by knee braces riveted in the corners between columns and floor beams. The tower, which rises 107 feet above the roof, on account of its exposed position, has been planned to resist a wind pressure of fifty pounds per square foot.

The weight of iron and steel in the building is nearly 12,000,000 pounds, of which 2,000,000 pounds are contained in the construction below the Broadway sidewalk. The metal construction from the level of Broadway to the roof was erected in three months. The cost of the building lot was about $1,500,000, and the cost of the building itself amounts to about an equal sum.

The structure will be the highest office building in the world, and one of the most conspicuous examples of this typical American creation, the skeleton structure. It will be interesting to watch the development in the construction of office buildings. It is quite likely that in some future building the considerable value of well-located rooms underground will bring about the plans of sinking one or more pneumatic caissons over the entire lot to be occupied, and of carrying the columns themselves through this. Then the caissons could be converted into a room or rooms. This plan would be entirely feasible, and in view of the space gained, probably economical. As the walls could be made absolutely tight, there is no reason why by the use of proper means of ventilation, and of tile or marble finish, attractive rooms for restaurant or other purposes could not be obtained. It would certainly save time to go down one or two stories instead of going up eighteen or more.

The great modern office building may really be called a bridge on end, and it calls for the same engineering skill in design, both superstructure and foundations, that is given to large bridges. The architect and the engineer must work hand in hand if the results are to be obtained that will endure and be worth the vast sums expended.—*N. Y. Sun.*

## A REMARKABLE ARTESIAN WELL.

The engraving illustrates the overflow from a remarkable well recently sunk for the town of Spalding. This well was completed at Bourn, Lincolnshire, by C. Isler & Company, London, as a means of supply for Spalding. No records, as far as we know, says *The Engineer*, are published of springs being tapped in England yielding a larger quantity of water than this one at Bourn.

At a depth of 100 ft. from the surface the yield was 1,872,000 gallons per day, and on the advice of Messrs. Isler & Company it was resolved to carry the bore deeper, with the result that at 134 ft. over 5,000,000 gallons per day are now obtained. The overflow really proved wonderful, and unless means had been taken for carrying this water away into a dike, which runs into two rivers, the country around would have been flooded. Precautionary measures had to be taken in this instance, as in a former one, to insure that no water should escape outside the tube. Owing to the great pressure which exists there are several boreholes in neighboring districts which allow a great portion of the water to escape outside the tubes, causing an unnecessarily great waste.

In the Bourn well there are three tiers of pipes inserted in the borehole, and each tier of pipe brought to the surface, and each driven tightly into the soil, the annular space being filled in with specially prepared cement.

Previous to tapping the main springs chalybeate water was met with at 65 ft. 10 in. from the surface. This was safely eliminated by the driving of the 13 in. pipes, which are the main supply pipes of the boring.

At 78 ft. 6 in. from the surface the main springs were tapped in the Lincolnshire oolite, the water rising very slowly, and took twenty-four hours to overflow from this depth. But on continuing the boring deeper the volume of water rapidly increased, with the result that at 100 ft. the supply was 1,300 gallons per minute overflow, or 1,872,000 gallons per day. At 120 ft. from the surface the amount of overflow was 1,800 gallons per minute; and at 134 ft. nearly double the amount, namely 3,480 gallons per minute, giving a result of 5,011,200 gallons per day. The pressure remained at each depth the same, namely, 10 lb. to the square inch. The water flows, by gravitation, through ten miles of pipes to the company's reservoirs at Spalding.

We give an illustration of Messrs. Isler's Crown diamond rock boring and percussion boring machinery. The engraving also shows the gantry standing over the machine for withdrawing the tube and the core, or for carrying the monkey or other apparatus for driving the percussion tools or the tubes, and also for suspending the boring tool and giving the required feed downward.

## GAS ENGINES FOR DRIVING TRAMCARS.

The application of gas for driving tramcars has recently attracted considerable attention on the Continent and has provided material for two lengthy papers in the pages of the *Journal fur Gasbeleuchtung*. From reprints of these we observe, says the *Journal of Gaslighting*, that much of the matter is common to both, and the substance of the two papers may conveniently be presented to our readers in one article. Herr A. Kemper, chief engineer of the Dessau Works of the German Continental Gas Company, communicated one paper to last year's meeting of the German Association of Gas and Water Engineers, and Baron Gostkowski, of Lemberg, is responsible for the other.

Both the authors enumerate the various methods which have been used or proposed for the driving of tramcars. Steam is dismissed as unsuitable for use on roads, on account of the excessive weight of the locomotive cars and the heavy permanent way required, apart from the annoyance caused by smoke, steam, ashes and sparks escaping. Compressed air is used for driving tramcars at Berne, but it is too expensive for general adoption. For the same reason, or for want of exact information, carbonic acid and ammonia motors, as well as Connelly's engine for the consumption of vaporized naphtha, are discarded. Herr Kemper alludes to the cable tramway; but he considers it only suited for use on very steep gradients, where a system dependent for traction on the adhesion weight of the cars would be quite inadmissible. The first cost of cable tramways is high, and the breakage of the rope brings traffic to a standstill. There remain then only three sources of power deserving consideration—viz., horses, electricity and gas.

Objection may be taken to the use of horse power on sanitary grounds, as well as on account of the lack of precision in stopping, and the generally uncertain control over power possessed of volition. On the other hand, horse power readily adapts itself to the resistances to be overcome, and on rises and curves a horse can exert ten times its normal power for a short time. The horse power unit of 75 second meter-kilogrammes adopted in mechanics represents the force a horse can exert continuously, and it is evident that mechanical motors for tramcars must be of at least 8 horse power in order to cope with considerable temporary obstacles. The cost of horse traction for tramways will be estimated later.

Electric tramways have found extensive use in America, and they are viewed favorably in Germany. It is evident that, in order to gain adoption, gas must be proved to be able to compete with electricity for driving cars. The methods of applying electricity for this purpose and its cost in each case must be briefly considered. The chief difficulty with electric cars lies in the conveyance of the energy to the motors attached to the car. There are three methods by which the energy may be supplied to the motors—viz., (1) from accumulators, (2) from underground cables, (3) from aerial conductors.

The ideal method is by means of accumulators, as each car carries its own source of power and is independent of conductors; but trials in many places—notably in Brussels and Hamburg—have not resulted in its general adoption. The reason lies in the heavy weight (from two to four tons) of the accumulators, their unsuitability for yielding a varying current, the necessity for changing them every three to five hours and the great loss of energy rendering the cost of working extremely high. The second method of supply—with an underground conductor—has also been but little adopted. Its first cost is high, and the narrow conduit open to the street is objectionable to other traffic, besides needing very perfect drainage, if interruptions through access of water and various objects are to be avoided. In Budapesth, where this system is at work, few interruptions occur; but the expenses are very high. Thus the only generally available and cheap electrical tramway system is that with overhead conductors, which is in operation in many German towns. In expense of working, it compares favorably with horse tramways; but the initial outlay is greater. On æsthetic considerations it must meet with disapproval, on account of the conductor being placed some 18 feet above the roadway, with its obstructive supports disfiguring the paths.

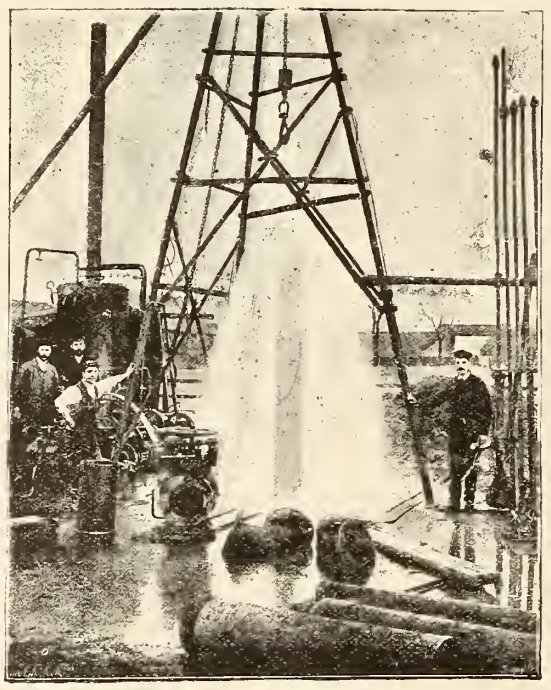
Each track, according to this system as in use at Halle, has two overhead conductors, joined at intervals of about 200 yards, so that a break in the working conductor may not cause the interruption of the current throughout the line. Beneath the body of the car are two electro-motors, each of 15 nominal horse power and each driving one of the main axles. They work either together or singly. The motors make 1,200 revolutions per minute; and by cog or chain gearing this number of revolutions is reduced in transmission to the driving axles. The resistance boxes and regulating apparatus are attached to the platforms. The cars weigh about 5 tons, or, with the complement of 28 passengers, about 6½ tons. For the rate of 10 feet per second on a level track, Herr Kemper calculates that the electro-motors must develop about 4 horse power, which, allowing for losses, means at least 6 horse power generated at the central station. The electro-motor cars are superior to others on up gradients. They are capable of maintaining their normal speed on a rise of 1 in 15. According to the statement of an electrician, the working expenses, including depreciation, of this system of electric tramways, may be taken at 20 to 25 pf. per kilometer run (4d. to 5d. per mile). The working expenses of a single horse tramcar are estimated at 22 to 28 pf. per kilometer. So the electric system is cheaper in working; but the greater capital outlay makes the return nearly the same.

Tramways with gas-driven cars may now be considered. The receptacles for carrying coal gas on the cars resemble the reservoirs used on railway carriages for compressed oil gas and the compressed air reservoirs used on the tramcars at Berne.

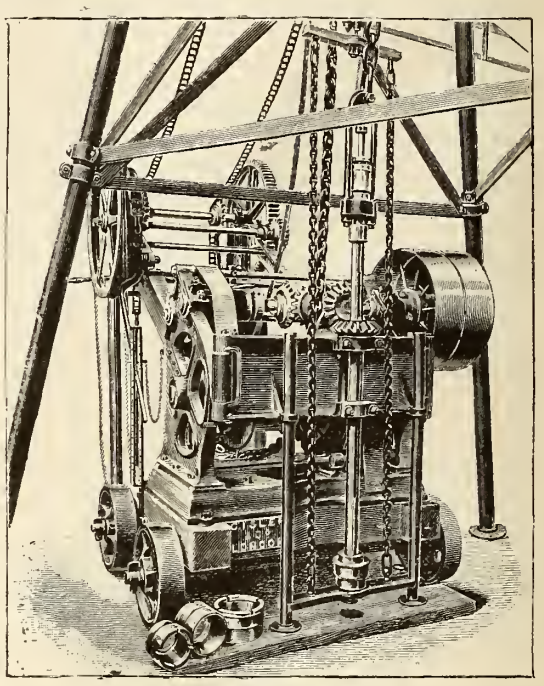
The gas supply may be taken from the street mains; but one or more compressing and filling stations are required. These should cost, with all accessories, from 400*l.* to 600*l.* According to Herr Kemper's project, an 8 horse power gas engine drives a compressing machine which is capable of compressing 2,100 cubic feet of gas (at 8 atmospheres) per hour. The cylinder of the compressor has a diameter of nearly 6 inches and a stroke of nearly 13 inches. A pipe 1¼ inches in diameter leads from the compressor to the storage vessels, which have a united capacity of 400 cubic feet. At 8 atmospheres pressure they can give to the car reservoirs 800 cubic feet at 6 atmospheres—sufficient to charge two cars.

The charging of a car is accomplished in about a minute. The compressing station is only 13 feet wide by 20 feet long. The gas engine used to drive the compressor consumes about 8 per cent. of the quantity of gas compressed, or 1 horse power compresses about 350 feet.

Two systems of cars have been devised for propulsion by gas power. The firm of Guillieron & Amrein, of Vevey, Switzerland, are the manufacturers of the cars used on the Neuchatel to St. Blaise line. Neither of the authors is able to give much information on the working of these cars. They weigh 6 tons each, and carry 20 passengers; they are driven by an 8 horse power twin gas motor on one of the platforms, and consume, according to different estimates, from 24 to 33 cubic feet of gas per mile run. The line is a little over three miles in length, and the car reservoirs hold suffi-



ARTESIAN WELL AT BOURN, LINCOLNSHIRE.



BORING MACHINERY.

cient gas for the out and home journey. The cars cost 600*l.* each; but the power provided seems scarcely sufficient to overcome the rises—up to 1 in 30—which occur on the line. The condensing arrangements are perhaps superior to those of the other system, which is that of Herr Luhrig, of Dresden. Trial runs have been made on the Dresden tramways with cars constructed on Luhrig's plan; and the cost of working is calculated therefrom by both authors. There are ten small gas reservoirs on each car—two on the roof, the remainder beneath the body of the vehicle—having a united capacity of from 45 to 65 cubic feet. As they are filled to six atmospheres pressure, they contain, when freshly charged, six times this volume of gas. The pressure is reduced by means of regulators similar to the Pintsch governors on the supply pipe to the engines. These are two, each of 7 to 8 horse power, so placed under the seats that the fly-wheels are outside and below the seat backs, but do not protrude beyond the sides of the car. Both gas motors drive one shaft, which gears by cog wheels on a second shaft, from which, by means of chains, the power is conveyed to the axles of the car.

By the aid of controlling levers, the driving shaft can be caused to turn at three different speeds. The slowest is for use when the motor runs free, as during short stoppages; the medium one, for ordinary running, and the fastest, for heavy work. The controlling levers on the driver's platform are as follows: A foot lever for controlling the gas motor; a hand lever for altering, by means of a clutch coupling, the rate from medium to fast, or *vice versa;* a hand lever for controlling the direction, backward or forward, of traveling; and a hand wheel, which, by means of a friction clutch, simultaneously applies the brakes and allows the motor to run free. By means of these, any desired maneuver can be carried out with greater ease and simplicity than might at first glance be supposed. Ignition is effected by means of a small electro-magnetic apparatus. The condensing water is carried in a tank on the top of the car and circulates automatically; so that it seldom needs replenishing. Galvanized iron plates, with flaps opening to permit of inspection, shut off the motors and machinery from view. No noise from the machinery is perceptible in the car while traveling; but when stopping the machinery running free makes a slight noise, and a little vibration may at the same time be felt. The large car for level roads can carry at least 29 persons; but Herr Luhrig has constructed smaller ones for use on heavy gradients.

The first cost and the working expenses of the Luhrig tramcars are discussed at length by both authors; but as they take somewhat different data for the calculations, the results are not strictly comparable with one another, though each may be fairly compared with the cost of electric tramway traction arrived at by the same writer. Herr Kemper estimates the cost of construction of a tramway five miles in length, with all appurtenances for gas, electric and horse traction. The respective amounts are 30,000*l.*, 38,000*l.* and 28,000*l.*; so that the first cost of a gas tramway is slightly higher than that of the horse line, but considerably lower than that of the electric tramway. This is largely due to the necessity for constructing a central station for the supply of electrical energy; whereas every town where tramways are adopted will have a gas works.

As the tramcar motors work almost entirely in the daytime, when the ordinary consumption of gas is at the minimum, the use of gas for driving them would tend greatly to equalize the consumption in a town, and so indirectly render the management of the works an easier task than it is at present. Then, taking gas at 3s. 4d. per 1,000 cubic feet, the cost of working, with allowances for depreciation of rolling stock and machinery, is arrived at for a year; and from this the cost per car per mile run is calculated. It amounts to almost exactly 3d. If gas is taken at 4s. per 1,000 cubic feet, the cost per mile per car would be about ¼d. higher. Herr Kemper computes that the working expenses of a one-horse tramcar are 4s. 2d. to 5s. 4d. per mile; those of an electric car, 3s. 8d. Taking the average number of passengers in the tramcars in Germany in 1889, he reckons out at low fares the receipts of such a line as the one projected above. He finds that, whereas the electric line would yield no return to shareholders, the gas motor line would certainly pay 6½ per cent. on its capital.

Baron Gostkowski, who studied the working and cost of gas-driven tramcars with a view to recommending their adoption in the town of Lemberg, takes the heating power of Lemberg gas for the basis of his calculations, and arrives at nearly the same result as the Dresden gas actually gave in working. He then calculates, with considerable detail, the gas consumption and working expenses for the projected line of 5½ miles in Lemberg. As the gas works will be under the municipal authorities at the time when the tramway could begin work, he takes gas at the cost price of 1s. 10d. per 1,000 cubic feet, and finds that traction would then cost about half of the average cost of horse traction on the tramways of a number of Continental towns. Finally, he computes the cost of traction of a car by electricity on the aerial conductor system; and, allowing for interest on capital, he shows the gas motor car to be 24 per cent. cheaper in working than the electromotor car. He further states that Connelly's system of driving cars by gas generated on the cars themselves from naphtha, which has been adopted in Chicago and other American towns, can be worked there at one-third the cost of horse tramways, and one-half that of the electric line. Though it is being tried on one of the lines in London, this oil-gas motor is more likely to be adopted in oil-producing countries than elsewhere.

## ANTI-FRICTION COMPOSITIONS FOR BEARINGS AND OTHER PURPOSES.

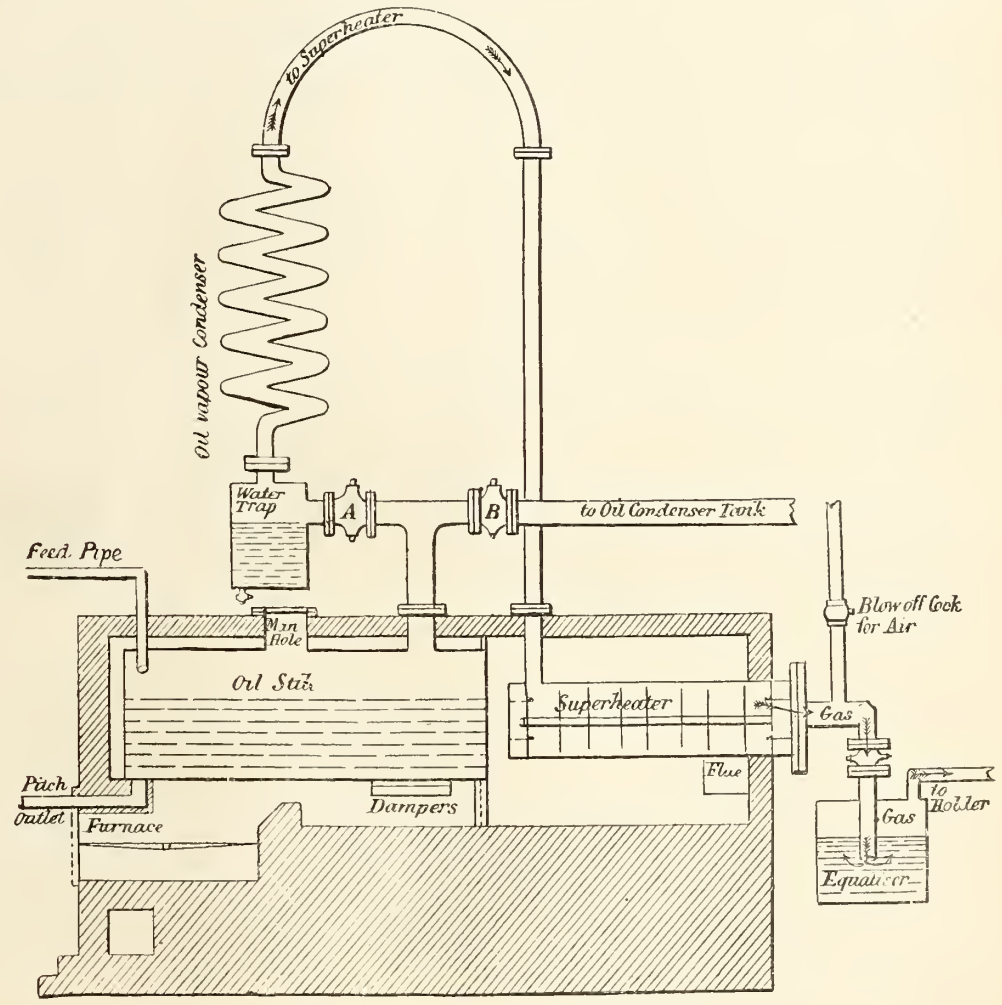
By H. F. HOVELER, London.

FOR packing rings and segments a mixture is used containing about 30 per cent. of asbestos powder and 70 per cent. pulverized white metal; for bearing shells, footsteps, bushes, etc., a similar mixture containing about 30 per cent. asbestos powder, 20 per cent. graphite powder, and 50 per cent. pulverized white metal. When the powders are well intermixed about 10 per cent. of tannic acid is added, and the whole poured into hot glue and well stirred; a tough, sticky cement insoluble in water results, from which any glue or tannic acid present in excess can be removed by washing in hot water; a mouldable paste is thus obtained, which is pressed into the required shape and dried in the open air for some days, finally at about 250° F. for some hours. The rings, etc., thus prepared are as hard as any real metal, and when polished possess a bright metallic luster; for steam or hydraulic packings they should be prepared from the first mixture and subsequently boiled with tallow, so as to fill up the pores completely; the second composition, containing graphite, must be used without oil or water, being self-lubricant; better anti-frictional results are said to be obtained with such bearings than with ordinary oiled pillow blocks.

## MANUFACTURE OF OIL GAS.

By JOHN LAING, F.I.C., etc.

THERE are three convenient methods by which mineral oil can be readily decomposed, viz., by repeated distillation into self; by radiant heat; and by distilling under pressure. In the system which I now bring before your notice for the manufacture of oil gas, I employ a combination of these three methods working in harmony together. Mineral oil gas making is nothing more than the "cracking" operation carried on to extreme. The apparatus consists of an oil still charged with a quantity of oil consistent with the number of cubic feet of gas it is desired to be made. This oil is vaporized by heat, either direct from a furnace for itself or by using the surplus heat from coal retorts, where they are in use. The oil vapors, as they leave the still, pass into a condenser so arranged that the more condensable portion on being liquefied returns immediately to the still for *redistillation* and




IMPROVED OIL GAS APPARATUS

condensation; the lighter portion passes over and down into a superheater, and then, coming into close contact with the *radiant heat* found there, is further decomposed and rendered into permanent gas of very high illuminating value. The back *pressure* on the still, from the gas holders, raises the boiling point of the oil in the still, and thus assists in its decomposition.

Between the still and the condenser I place an arrangement which acts as a water trap, so that should any water happen to get into the still with the oil, it will be removed without any trouble or fear of accident. If this water trap were not employed, then the steam from the still would condense in the condenser overhead, and this water, returning to the still (which is now at a higher temperature), would suddenly burst into steam, and might prove dangerous

This trap catches all the condensed material from the condenser, and should water be present it will fall to the bottom, beause it is heavier than oil; the overflow of oil from the surface returns to the still perfectly free from water, and during the remainder of the distillation there is no possibility of further trouble or anxiety on account of water in the still. This trap is fitted with a cock at bottom, and when you turn it on and find oil, you may rest assured that no water is present to be dealt with. Sometimes it happens that water is present in the oil tanks from which the oil is barreled, and if the tank is well run down, some water may have got into the barrels along with the oil unperceived. In this way water may find its way into a still when being charged from the barrels or tank, but with the arrangement I have here mentioned no harm can result from its presence.

In the form of superheater I am using at present I have a number of disks with holes punched through one half of its surface, and the edges of the disks are vandyked or nicked. These disks are fitted on to an iron rod at regular intervals from each other; the end disk has its holes downward, the next one has its holes upward, and so on to the end, thus giving the gas a zigzag travel, and making it come in closer contact with the radiant heat in the superheater. My reason for giving the gas this zigzag travel is to insure a uniform quality of gas being made. If you merely pass the gas through an empty superheater direct, then that portion of it which is nearest the sides of the vessel is decomposed the most; the central portion is of a heavier nature, and I am strongly of opinion that this mechanical mixture of the molecules (if I may use such an expression) is one great cause why some makes of oil gas smoke so badly on being consumed in the burners. If the hydrocarbon molecules are of a uniform character, then you will have a gas which will give satisfactory results on being consumed. I am quite aware that a proper size of burner should be employed for consuming very rich gases, but what I mean to convey is that using two makes of oil gas and consuming them side by side under the same conditions in every respect as to burners, pressure, etc., you will find that the gas which has been the result of uniform decomposition will give more satisfactory results than the gas which is not so uniform in its composition, and being more a mechanical mixture of its component parts than a chemical one. Oil gas of uniform composition blends immediately with coal gas, and I believe has no tendency to layering in large holders, and accordingly you should have no variation of illuminating value from different heights of the gas holder. Some people seem to think that oil gas does not store well, and that it loses a deal of its illuminating power if it has to travel far. Now this is quite a misconception, for really the fact is that if oil gas is properly made, it will store better, and travel better, and stand cold better than coal gas will, for coal gas depends more on condensable vapors for its illuminating power than oil gas does.

The lower temperature at which you can make permanent oil gas, the better results you obtain. You get a higher illuminating gas, less deposit of carbon, and you get a larger quantity of gas from your oil than if you are decomposing your oils at higher temperatures.

By my process all the dirt is left in the still, and in time produces a pitch of first-class quality; this pitch being liquid while hot, is readily run from the still by an arrangement provided for that purpose, and leaves behind practically a clean still ready for the next charge. Before running down the still bottom it should be sampled first, and if the condition is too soft when cold, that indicates that you can yet take more oil from it, and by leaving it longer under heat you will obtain all the more gas and a better pitch. If for any reason you prefer to have coke to pitch, then just carry on the distillation to dryness, and coke will be the residue instead of pitch. The samples which I now send round are pitch and coke from the same oil. The coke is merely the result of continued distilling heat on the pitch. The best prices for this coke range to about 21s. per ton. This pitch has been valued about 37s. per ton, and had it been taken off a little later from the still, and accordingly been harder, its price would have been higher by a few shillings per ton.

It takes a higher temperature to produce coke, and I prefer to work to pitch for several reasons, viz.:

1. It is not so hurtful to the plant.
2. If you are using a furnace instead of surplus heat from coal retorts, then it takes less fuel, and thus is cheaper to make.
3. It saves a deal of cleaning of stills.

4. It can be stored anywhere and for any length of time without deterioration.

5. It is of higher commercial value.

If you take a red hot still and trickle in slowly say one gallon of oil, and allow the vapors to escape through a sealed condenser of three inches water, you will have a larger amount of coke formed than if you distilled down the same quantity of oil from a charged still with oil under the same conditions. You will thus see that the quantity of pitch obtained by my method of oil gas manufacture is less in proportion to the amount of coke formed by other high temperature processes. Coke is a worse conductor of heat than pitch is by a long degree. It is no uncommon thing to see a still bottom bright red hot with a layer of coke at the bottom and several inches of pitch on its upper surface, and yet the pitch was not strongly giving off vapors.

I may here mention that I have arranged a special pitch cock which will save a deal of trouble by its being easily kept free from plugging up. In the ordinary cocks at present in use, the box or hole in the plug of the cock often retains some of the pitch, and as it cannot escape when the barrel is turned off, it remains and hardens there, and, before another run down can be made, time must be allowed for the hot pitch behind the cock to melt out the plug in the cock barrel. This is sometimes rather difficult to get over, and a steam jet has to play on it for some time before it will clear. To get over all this I got a cock specially made with a "pap" cast on the one side of it; a hole was bored through into this plug box, so that when the plug was turned off a hot wire can easily be passed into the hole and all the pitch cleared out. A screw plug fits into this hole. It might, perhaps, even be further improved by having a "pap" cast on both sides and a hole in it so that a hot wire could pass right through and through, and thus clear the cock with the greatest ease. This method is extremely simple and most effective, and far better than the present system of running a red hot rod up the pipe in line with the cock and melting out the plug. Sometimes the obstruction gives way with a burst, and there is great danger of the person so operating being seriously scalded with the hot pitch from behind coming quicker than he can get the rod removed.

In other processes for oil gas making the oil is injected or run in a stream into the heated retorts or stills; in this way the oil is at once flashed into vapor. What has been rendered permanent goes to the holders, and what condenses again into oil is returned to the still. By this method you obtain an immediate deposit of coke which goes on increasing in thickness as long the feed continues to supply the oil. As this coke deposit increases you must have more heat to enter your still so as to vaporize your oil, and I rather fear that this coke acting as a foreign body in the still will soon set up inflammation and burn it through. By my method I never require a higher temperature than a very little over the distilling point of the oil in use.

If you prefer to use a large size still, then you may work on a large body of oil and distill down as many inches as you require, then draw off the heat by opening the damper to the chimney, and leave the still and its contents as it is till next making time. Nothing leaves the still but vapors, the condensable portion of which continuously washes down the condenser coil and other pipes connected to the still, and keeps them clean and free from deposit, all the dirt remains in the still, and according as the oil you use is crude or partly refined, so you have a greater or less amount of pitch formed in the still. At present I prefer to use the 0·840 or 0·865 unwashed home oils, as the gas from them requires no lime or other purifying treatment. If you use an oil too near the crude state, it would be the better to pass the gas made through the purifiers to remove all traces of sulphur and ammoniacal compounds which are apt to be present at that stage.

Where oil gas is being consumed, it should be burnt in a smaller size burner than that used for ordinary low-power coal gas. You should have a burner which will just prevent smoking. If you use burners much below this point, you get a very much poorer light, owing to the cooling of the flame.

I understand it has been shown that a Bray No. 0, showing 50 candles for 5 cubic feet burnt and giving a good smokeless flame, if the same gas, under the same conditions, was burnt in a No. 000 burner, would show a loss of 35 candles for the same amount of gas consumed.

I find a burner passing 1¾ feet per hour will answer very well for general requirements. By my arrangement large or small works are equally served and no duplicating of plant is necessary for large works; you only require to have a larger or smaller still and condenser in proportion consistent with the amount of gas required. Any kind or quality of oil can be employed with absolute confidence. No skilled labor is required. Keeping up a distilling temperature is all that is necessary to give special attention to. The cost of the plant is not great. I would venture to say that a plant capable of yielding 20,000 cubic feet of oil gas for 24 hours should cost within £100, and such a plant could be fitted up on a ground space of not more than 8 feet square.

There is nothing to get out of order, there being no mechanical parts requiring attention. The whole thing works automatically.

The attendant never requires to soil his person or dress as in a coal gasworks, and the atmosphere is not polluted with offensive smells from lime purifiers, etc. By arranging a ª ſ ᵇ piece outlet on the still, provided with cocks at A and B, you can have a very useful combination of still suitable for gas making and oil refining combined. Suppose you have an oil which contains some light material you do not wish to retain, you can readily convert that portion of it into illuminating gas in the manner described, then by shutting off the cock at A and opening B you can convey the remaining vapors of the heavier remaining oil to an ordinary worm condenser and there run them off in the usual way into receiving tanks, at the same time shutting off the heat going to the superheater, as it would not be required. Should such a combination be desired, it would be well to have provision made for a furnace to assist the surplus heat from the coal retorts (if such heat is being utilized), because a smarter heat is better for distilling oil than for gas making; for the reason that if your oil vapors are kept too long in the still in contact with the radiant heat found there, you will have your viscosity greatly ruined, and an oil of lighter specific gravity the result. The smarter heat quickly vaporizes the oil, and accordingly the vapors are less time under heat in the still. The lower temperature at which you distill mineral oils will yield you the heaviest qualities and the greatest viscosity obtainable from such oils. As to the cost of production of oil gas, I would just say that if you are using the surplus heat from coal retorts alone for your oil gas plant, then the cost of the oil gas is practically the cost of the oil you are using. It is not my intention here to enter upon the subject of advantages claimed for oil gas. They are well known and generally accepted.

It may be stated generally that one gallon of mineral oil will yield, off or on, about 100 cubic feet of oil gas with an enriching power of not less than 90 candles, if properly made.

Suppose you are using a poor splint coal yielding an 18 candle gas, then by using five parts of this to one part of oil gas, you would obtain a gas of 30 candle power. It is a very simple matter to arrange for a gas of almost any candle power, by merely adding a greater or less proportion of oil gas to your poor coal gas. Oil gas can be burnt by itself with great acceptance, provided you use suitable burners.

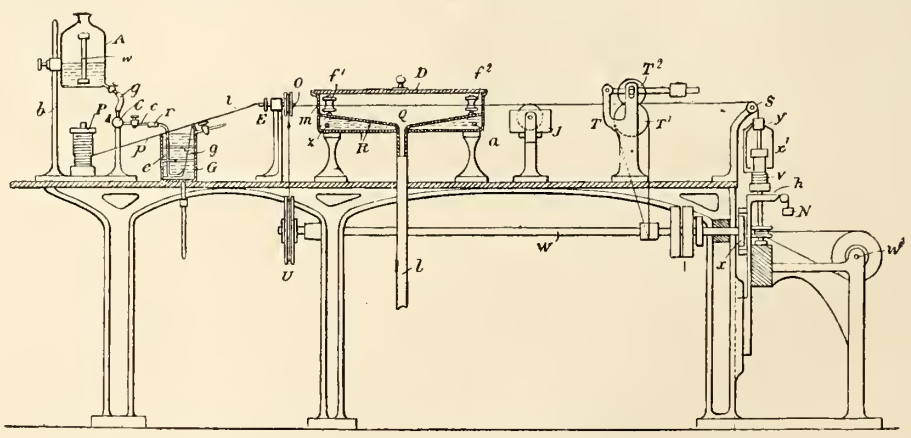
In conclusion, I would strongly recommend that all gas companies should have an oil gas plant in reserve, at least if not in actual use, for should they run short of coal, through miners' strikes or other causes, they can yet prevent, in a great measure, having their towns left in total darkness by the timely use of their oil gas plant. The space required for storing an enormous quantity of oil gas, in a latent stage, is not very great.

*Note.*—Some gas managers prefer to use a proportion of shale mixed with their coal in the retorts, so as to get the benefit of the high illuminating power from the oil gas made from the shale. Judging from my experience with oils, I would be inclined to say that they do not get the full value of this shale oil as an enriching agent, for a large quantity of its vapors will not have been rendered permanent, and I think they will find considerable quantities of oil condensed into the "drips" or "siphons" or run away with the tar.

P. S.—Since reading the above paper I have made an alteration in my apparatus, by interposing a tank between the return pipe from the coil condenser and the superheater, in order to trap any excess of condensable vapors which, from some cause, should pass over from the coil condenser. Any oil in this tank finds its way back to the still again by a pipe connected by a siphon bend near the bottom of the tank, and opening into the still. The siphon bend remains full of oil, and acts as a seal to the vapors from the still escaping by that opening into the still. Some oils have a tendency to froth or boil over, but with this arrangement any oil which should at any time get over from the condenser would immediately return to the still. Near the top of this tank is an offset pipe, which connects with the superheater, so that gases only are passed through the superheater, and in this way a regular and decomposing temperature is maintained on the superheater and risk of oil getting into the equalizer avoided.—*Jour. Soc. Chem. Industry.*

## IMPROVEMENTS IN MACHINERY FOR PRODUCING ARTIFICIAL SILK.

A solution mainly composed of nitrocellulose is made to flow from small orifices into a liquid, such as water, turpentine, etc., and is drawn out into a fine thread. To produce such a thread from a 5 per cent. solution of nitrocellulose is a comparatively easy matter, but when, in order to obtain stronger threads, the nitrocellulose in solution is raised to 10 per cent., the solution becomes so thick that the production of a thread requires a pressure of several atmospheres to make it flow through fine orifices. The inventor gets over the difficulty by treating a strong nitrocellulose solution with sulphuric or other mineral acid. As an example, to a 20 per cent. solution of nitrocellulose in wood spirit or ether, 1-2 parts of sulphuric acid (66° B.) are added, and heat is applied. A compact precipitate, redissolving on shaking, is produced, and the solution is then much clearer and more mobile than before. The machine for manufacturing the threads is constructed as follows: The reservoir, A, which contains the solution, is provided with a gauge glass, *w*, and can be adjusted higher or lower on the support, *b*. The reservoir is also connected by a rubber tube, *g*, to a pipe, C. This pipe, C, has a number of outlets, connected by a number of rubber tubes, *r*, to a corresponding number of S-shaped glass tubes, *e*. The upper bend hooks over one side of a trough, G, the lower bend is close to the bottom of this trough, and the bent-up end is made to terminate in a narrow aperture. From this narrow aperture the solution enters the soldifying liquid contained in G, and is then drawn out and extended into threads. Any suitable solidifying liquid may be used, as, for example, turpentine, or water, or petroleum. The glass tubes are kept separate in the trough, G, by loosely inserted glass partitions, which do not impede the circulation of the liquid, but prevent the filaments from becoming entangled, should any filament break. Any number of the filaments, *i*—seven is a suitable number—are, as they form, conducted jointly to guides at E. At E, if desired, a thread or filament, *p*, of any other material, natural or artificial, may be added, for instance, a cotton thread, real silk thread, or others. This additional thread is contained on the spool, P, and is guided from the spool below the tube, C, over the trough, G, to the guide, E. The united filaments, *i*, and the natural filaments, *p*, are now steadily drawn off by the mechanism, T, and then guided through a narrow aperture, *m*, to the drying chamber, Q, which is closed as air tight as possible, and provided with a lid, D. On leaving the drying chamber the filaments reach the denitrating appliance, T. This consists of a roller partly immersed in a denitrating liquid, by preference ammonium sulphide, which removes a portion of the nitro groups and neutralizes any free acid which may adhere to the filaments. By the drawing forward mechanism, T, the filaments are then drawn over the guides, S, to the spinning apparatus, $x^1$, which may be of any known suitable construction.—*F. Lehner, Zurich.*

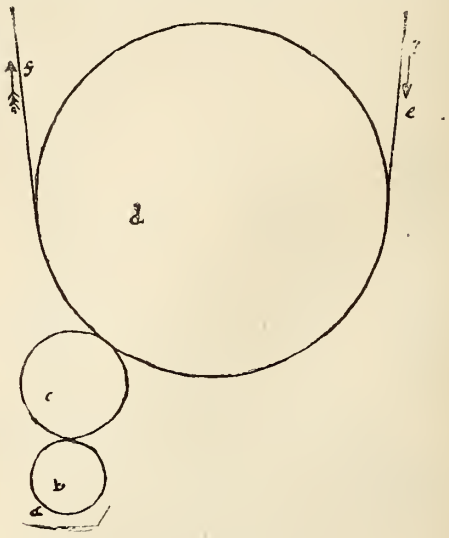


MACHINE FOR PRODUCING ARTIFICIAL SILK.

## CALICO PRINTING MACHINERY.

By John Waterson.

With the exception of one or two styles, the whole of the calico that is printed is done on the cylinder printing machine. This is a Scotch invention, brought out about the year 1770-1780, and about 1830 was practically as we find it at the present day. The principle on which the machine works we will now explain by the help of the diagram. The cloth to be printed, *e*, passes around the bowl of the machine in the direction shown by the arrows. The bowl, *d*, is lapped with several thicknesses of blanket, in order to provide an elastic but firm bed for the cloth, and one which will press the cloth well into the engraving. The printing color is contained in the color box, *a*, which may be constructed of wood or copper, and the color is supplied to the engraved printing roller, *c*, by means of the furnisher, *b*, which is a wooden roller covered with cloth. The furnisher presses the color into the engraving, as well as smears the surface; the surface color is then removed with a copper-plated steel blade, known as the color doctor. The copper printing roller, charged with color, then comes in contact with the piece to be printed; the latter soaks up part of it and the remainder is transferred on account of the pressure on to the face of the cloth. The cloth then passes on to the next roller, or if it is only a single color pattern, to the drying chests.



The lapping used on the bowl of the machine has a linen warp and woolen weft, ten thicknesses being generally employed. The thickness of the doctor to be used depends upon the character of the engraving on the roller, a thick doctor being used for heavy engraving, such as blotch work, and a rather thinner one for fine engraving, as small sprig or flower patterns. The average thickness of the doctors employed is about 23 on the standard wire guage. The furnishers can be driven either in the same direction or in the reverse direction to that in which the engraved printing roller is traveling. With most of the colors the furnisher is worked in the same direction as the printing roller is going, and generally in such cases a lapped furnisher is placed in the color box; but when pigments or any color liable to stick in the engraving is being printed a brush furnisher is preferable, and it should be driven the opposite way to that in which the copper roller is

revolving. For fine patterns a very soft furnisher should always be used.

In addition to the color doctor, there is another doctor at the other side of the printing roller, the object of which is to remove any lint or "fluff" that may have come off the face of the piece and thus prevent it being carried into the color box. Lint soon finds its way to the color doctor and lifts it, with the result that the piece is streaked until the lint is removed.

Many colors are very liable to froth in the box, and this is particularly liable to occur if the machine is run too quickly. If the machine is run at too great a speed, the cloth has not time to take the color from out of the engraving, and is, consequently, badly printed.

A to and fro motion is always given to the doctors by various mechanical devices, such as by level wheels and cranks, eccentrics, or by cam and lever, the object being to cause the doctor to wear evenly. The doctor, if fixed in its position relative to the engraved roller, would be worn only by those parts of the roller in contact with it, viz., the plain parts and the edges of the engraved parts, hence the edge would soon become uneven. By giving a to and fro motion to the doctor, this is, to a considerable extent, avoided.

Formerly printing machines were driven by underground shafting, provided with clutches for various speeds, a choice of three being general. Now each machine is driven independently by means of a separate steam engine, and this is found more convenient and economical on account of the irregular service required of the motive power.

## THE LEAD INDUSTRIES IN GREAT BRITAIN.

THE committee appointed April, 1893, were directed by the Secretary of State to inquire (1) into the conditions under which lead smelting, the working of blue lead and the production of white, red, and yellow lead and litharge are conducted, with the object of diminishing any proved ill effects on the health of the workpeople engaged therein; (2) as to whether the special rules which already exist for the manufacture of white lead are sufficient; and (3) to suggest any precautions for the protection of life and health. They were further directed to inquire into the tinning and enameling of iron hollowware and plates, the death of Harriet Walters, and the use of red lead in electric accumulator works.

The committee visited 46 works in England, Scotland, and Wales, and examined 184 witnesses.

### I.—WHITE LEAD.

There are three processes by which white lead is produced: (*a*) the old Dutch process; (*b*) the chamber process; (*c*) precipitation. The first is the commonest, and the committee saw only three of the second and one of the third.

In the old *Dutch process* the desilverized metallic lead is melted and cast, sometimes into gratings, sometimes into thin oblong plates, with two holes and a central rib. In most works the casting is done by hand, women being often employed; in some, however, by machinery, which not only casts the lead, but delivers it at a convenient place some distance off. In the latter case, the only hand labor involved consists in putting the pig lead into the melting pot and reglating the flow of the molten lead. The gratings are next put into stacks, large cubical places built of bricks, the floor of which is just covered with a layer of tan. On this are arranged, as closely as possible, stoneware pots filled with dilute acetic acid, and on the top of these are placed four or five gratings, one on top of the other. Boards are then laid on the top of the gratings so as to form a new floor, on which tan, pots, and gratings are laid in the same order as before, and this is in its turn covered in the same way, and so on until the stack is full, as many as ten or more layers going into one stack. The filling is done through a vertical opening in one of the sides of the stack, which is closed by boards as the stack fills up. As the floors rise the various materials must be lifted up to them. This is generally done by women, who have to carry on their heads from 30 to 50 pounds of lead at a time up ladders 10 to 15 feet high. In some works the material is passed from hand to hand up stages or lifted by hoists worked by machinery. When full it is covered in, a ventilating shaft in each corner is provided, and the stack is then left to itself for from 10 to 15 weeks. The tan soon heats, evolves carbonic acid, and volatilizes the acetic acid. An interaction then takes place between the lead, acetic acid, carbonic acid, and the oxygen of the air, leading to the ultimate production of amorphous basic carbonate of lead or white lead. The action goes on until all the lead is corroded, or until there is no more carbonic acid evolved, or until all the acetic acid is volatilized. There is always some acetate of lead left in the final product. Then the stack is opened, and the white lead, which retains the shape of the lead grating, is taken out. It used to be taken out dry, but according to present regulations it is wetted first, to stop dust flying about. It is then carried in trays, generally by women, to corrugated rollers, over which passes a constant stream of water, and tipped down in front of them to be crushed, so as to detach any metallic lead left uncorroded. Before this is done the crates are either dipped in water or well watered to prevent dust rising, and even then some dust comes off. The crushed mass next passes into a shallow tank, with a perforated bottom, in which it is raked about to separate the pieces of blue lead from the white lead, which latter passes away with the current of water to grinding mills. Here it is ground up and then run into a series of tanks (washbecks) to settle. The water is then drawn off, and the white lead is removed, put into earthenware or copper pans, and placed in drying stoves. In some works the wet mud is run through a filter press, and the press cake put into the stove. The pressing not only greatly reduces the time necessary for drying, but renders the whole process more cleanly and free from dust. When thoroughly dry, which takes from three to five days, the pans are taken from the ovens by hand labor, and the white lead is either packed directly into casks or thrown into bins for subsequent conversion into paint. The above operations give rise to a good deal of dust, and in order to obviate it mechanical drying stoves have been invented for carrying in the wet white lead and discharging the dry into barrels by machinery. No perfectly satisfactory mechanical stove has yet been devised; they are also very costly.

The *Chamber process* is also one of corrosion, but a chamber is used instead of the stack, and the strips of lead are hung saddle fashion on sets of parallel bars. The chamber is heated by steam to a regulated temperature and the carbonic acid is supplied from burning charcoal by a flue, while pans of acetic acid are laid on the floor. The corrosion in this process only takes four or five weeks. The subsequent treatment is the same as the old Dutch process.

The quantity of white lead produced by *precipitation* is as yet very small.

*Effects of Lead.*—If lead, in however small quantities, enters the system, symptoms are developed, the most frequent of which is colic. Nearly all of those who work in factories on lead or its compounds look pale and anæmic and show a blue line on the gums. Lead palsy occasionally affects their hands. There is also a very sudden and fatal form of lead poisoning, most frequently met with in young women, which begins with headache followed by convulsions and unconsciousness. Death often occurs in three days, and in some cases of recovery from convulsions total blindness remains.

There is some doubt as to how the poison enters the system. The committee think (*a*) that it may be absorbed through the pores, particularly during perspiration or where there is friction between the skin and the clothing; (*b*) that it may get into the stomach by touching food with dirty hands; (*c*) but that the most usual manner is by inhaling the dust. Some of this dissolves in the mouth and is swallowed, and some gets to the lungs and is absorbed by the blood.

*Rules.*—The existing special rules under the Factory and Workshops Act, 1891, for white lead works are then cited, and approved so far as they go.

*Danger of Working.*—The committee find that the dangerous parts of the *old Dutch process* are: (1) the stripping of stacks; (2) the rollers; (3) the washbecks; but (4) chiefly in the stoves and packing. The committee find that (*a*) women are more liable to lead poisoning than men, and (*b*) young girls than full grown women.

*Recommendations.*—Lead was found as acetate and sub-acetate in the washbecks of certain works, and in one the quantity was large. The workers have to plunge their hands in these washbecks. The committee enjoin manufacturers either to treat the washwater so as to separate the lead or to discontinue letting the workers put their hands in the water.

The committee report that the special rules issued in 1892, as to cleanliness, medical inspection, and sufficiency of good food, have been of great benefit. Certain firms give their workers some food either before beginning work, at 11 o'clock, or at the dinner hour, and the committee trust that this will become universal in the trade. They recommend also that a new rule be added, whereby no female should be employed without examination, and a medical certificate that she is of the required age and fit for the employment; and further that no worker, after absence through illness, should be re-employed without a medical certificate that he or she has recovered. Also that no girl under 20 be employed in the old Dutch process, and that every woman be compelled to produce a certificate either of birth or baptism before she can be employed. Also that the stacks, rollers, washbecks, stoves, and packing be worked in future by adult male labor alone. The further use of mechanical appliances is also strongly urged, and recommendations as to clothing are made. In regard to the inhalation of lead dust, reference is made to Dr. Dupre's experiments, and the necessity of enforcing the use of respirators is recognized, of which the best form is considered to be a cambric bag made to fit over the nose. Workers are urged to co-operate with their employers in enforcing the regulations. No packing or storing of dry white lead is to be carried on except under a hood connected with a fan or other device for creating a draught, whereby the dust shall be carried away. A dining room must be provided, and no one is to take any food elsewhere in the works. Every stack is to be fitted with an adequate supply of water for damping the contents of the stack previous to stripping it, and water is not to be fetched from a distance. No stack is to be stripped before it is "mature."

### II.—SULPHATE OF LEAD.

This is manufactured directly from galena by throwing small shovelfuls into a coke furnace highly heated. The galena is volatilized and oxidized directly into sulphate. This is collected in chambers and then washed and dried much as in the case of white lead. There is not much danger in this process, as the sulphate of lead is less poisonous than the carbonate, but it does not possess either the color or the covering power of the latter. Mr. A. P. Laurie has recommended an experimental trial of white lead substitutes, but the committee think it better left to be settled by competition in the open market. The price of sulphate is from £3 to £4 a ton under that of white lead.

### III.—SUBSTITUTES FOR WHITE LEAD.

Several compounds have been mentioned to the committee as being equal to white lead. One of these is oxide of zinc. This has been used with success for internal work, but it does not bear exposure to heat, cold, and rain, nor does it possess the covering power of white lead. Moreover it is more expensive. All the other substitutes proposed have also proved to be in some respects inferior.

The committee have come to the conclusion that there is at present no substitute for white lead made by the old Dutch process. Also that this process may be rendered sufficiently free from danger to warrant its continuance with proper and efficient safeguards.

### IV.—RED AND ORANGE LEADS.

Orange lead is simply white lead heated in furnaces. Red lead works are frequently in connection with white lead works and call for similar special rules.

Red lead proper is blue lead oxidized at a low temperature. Pig lead is placed in a furnace, a large surface of which is exposed to heat and air. The metal when melted is not more than an inch or two thick on the bed. It is raked about by men through a door from which lead fumes escape. These are caught by a draught chimney and carried away. The safety of the furnace men thus depends on the efficiency of these chimneys. The lead is first oxidized to massicot, and in this state is raked out preliminary to a further treatment which is not described.

The committee recommend that instead of raking the massicot on to the floor, it should be shoveled into wagons, and that all packing should be forbidden in the place of making, but be carried on elsewhere under a hood with an effective draught. This also applies to orange lead. Baths and lavatories are enjoined, as well as medical inspection. Special drinks are also ordered.

### V.—LITHARGE.

No recommendations are made with regard to litharge.

### VI.—COLORS.

In regard to the manufacture of Milan red, vermilionette, Persian red, etc., the committee consider that the present rules for paint and color works will suffice, if respirators be made compulsory whenever dust is generated, and baths be provided in addition to the ordinary washing arrangements. No young male or female, however, is to be employed in such manufactures.

### VII.—LEAD SMELTING.

The ore is treated in a furnace and the metal extracted from it. The same precautions as to carrying off the fumes escaping from the door are used as in the case of red lead.

The committee recommend that only adult male labor shall be employed, with precautions as to respirators, clothing, length of work, and washing accommodation.

### VIII.—BLUE LEAD.

No recommendations are made in the case of working and desilverizing metallic lead.

In regard to pipe and sheet making, inspectors of factories are enjoined to take note of and report any cases of poisoning, which are stated to be rare.

Bullet and shot making are considered safe.

Plumbing and house painting are not included in the reference to the committee.

### IX.—YELLOW LEAD.

This color is made by mixing bichromate of sodium or potassium with lead salts. Reference is made to Dr. Scott's evidence, and the enforcement of the provisions he advocates is recommended. These are ventilation, use of respirators, and certain drinks, with abundant washing accommodation. No ill effects have been traced to the use of articles dyed or painted with yellow lead.

### X.—ELECTRIC ACCUMULATOR WORKS.

Red lead or litharge, previously damped with dilute sulphuric acid, is rubbed on to both sides of embossed or perforated leaden plates, so as to fill the interstices and produce an even surface. One man mixes the dry red lead and sulphuric acid, while others rub the mud into the plates. Gloves are used, but do not last long. Another method is to fit a piece of lead with projections into a mould and push in red lead enough to fill up the spaces. When pushed in tightly the whole readily comes away from the mould, which can be then used again. The red lead mud is also made into square cakes. In all these processes the hands of the workers come in frequent contact with the material, and in some cases gloves are not worn.

The compulsory use and inspection of gloves is recommended, with ample washing accommodation. The increased use of machinery is also considered desirable.

### XI.—ENAMELING OF IRON PLATES.

The iron plate, having been cleaned, is first smeared with a little gum and water, and then a fine powder, which may contain up to 25 per cent. of lead, is sifted over it. The plate is then heated in a furnace until the powder melts, forming the first coating of enamel. Another way is to put on the powder previously wetted with a ladle. The next process, known as "swilling," is to brush color, which nearly always contains lead, carefully over the plates. This is gone over with finer and finer brushes to secure an even surface, and the plate is then dried. Up to this point not much danger attaches to the industry, but it is in the next operation that most of the danger lies. The workers (women) place a stencil on the plate and rub off the exposed color with a nail brush. This comes off as a thick dust, and although they work on perforated tables, some dust inhaled. When the upper layer of color is rubbed through and the pattern appears clear and sharp the plate is again fired. The process may be repeated several times, according to the number of colors required. The lead used in the enamels is chiefly red lead, and the manufacture is a trade secret.

The existing special rules under the Factory and Workshop Act, 1891, for enameled iron plate works are then cited and approved, so far as they go.

The committee find that severe and sometimes fatal illness results to the workers in the stenciling process.

Frequent medical inspection is insisted on, no girl under 20 is to be employed, and no female without previous examination and medical certificate that she is of the required age and fit for the work, as in the case of white lead works. Enameling firms are also recommended to give each female worker half a pint of milk and a biscuit before beginning work. The perforated bench is also to be boxed in below and supplied with a fan to draw down the dust. A separate dining room is also to be provided.

### XII.—THE DEATH OF HARRIET WALTERS.

This girl, aged 16, was employed in an enameling works at Bilston, and the circumstances attending her death are detailed. She died of lead poisoning, a typical case. The committee criticise the medical evidence.

### XIII.—THE TINNING AND ENAMELING OF IRON HOLLOWWARE.

This industry of preparing kettles, saucepans, frying pans, etc., is largely carried on at Wolverhampton, Bilston, Dudley and the neighborhood. The article in

the rough, previously cleaned with dilute hydrochloric acid and chloride of zinc, is dipped into a "pit" containing a mixture of melted tin and lead in varying proportions, according to the quality of the goods. The leading firms use no lead for culinary utensils, but only when the article is to be japanned also. Such vessels are generally slop pails, coal scuttles, baths, etc.

The committee commends the suggestion of H. M. Inspector of Factories that the use of lead and arsenic in the enameling and tinning of culinary utensils should be absolutely prohibited.

Washing accommodation, with compulsory use thereof, and prohibition of eating, except in a specially provided room, are to be extended to this industry.

XIV.—REMARKS APPLICABLE TO ALL THE FOREGOING TRADES.

The duty of employers and workers is discussed in relation to the existing and proposed rules, and penalties for contravention are proposed; while the duty of reporting lead poisoning is placed on the same footing as that of reporting accidents. A summary of all the foregoing recommendations and suggestions is given, and after some remarks on the probable effect of these upon the lead industries, the committee record their conviction that lead and all its compounds are more or less poisonous and that the use of each or all of them is attended by danger.

## VARNISHING GLASS.

By Nelson K. Cherrill.

In a recent number of the *Electrician* it is mentioned that Messrs. Siemens & Halske have recently adopted the system of dipping lamps in a thin semi-transparent varnish to obtain the effect of ground glass. As the writer has had much experience in this class of work, a few notes of the best mode of procedure may be of interest. The application of various modifications to the normal appearance of a lamp by means of varnish, either colored or plain, is by no means a novel expedient, and a similar plan has, I believe, been commonly employed in many places for decorative work.

The most important point in the application of varnish to a lamp is to get it to dry just in the right condition. Most kinds of varnish that will dry "bright" under ordinary circumstances will become "matt" if subjected to a chill, or to the action of damp during the drying, and at the same time many varnishes intended to dry with a "matt" surface, that would represent ground glass, dry "bright," if the conditions of drying are not quite suitable.

The class of varnish best adapted to this kind of work is what is known as photographer's negative varnish. This class of varnish dries almost as hard as the glass itself, and when well applied is very durable. When colored lamps are needed, the varnish should be of a quality to dry "bright," but when the effect of ground glass only is required, the simplest way is to use what is known as "retouching" varnish, which gives a "matt" surface at once. In default of this, the ordinary negative varnish can be easily modified to give the desired surface by the addition of a little weaker alcohol, which almost always has the desired effect; but if there is any difficulty, a little common resin, which chills very easily in drying, may be added to the varnish.

As to the mode of applying the varnish to the lamps, the best plan is to hang them on a frame by their contacts, so that a current can be passed through them during the operation. The lamps should be well washed in warm water, in which there has been dissolved a liberal dose of soda. A thorough rinse with fresh cold water should be given, and the bulbs should then be carefully wiped quite dry with clean linen rags. If the work is to be very nicely done, the operator who hangs up the lamps on the screen should have on linen gloves, as finger marks on the glass are apt to show when the whole process is finished. The varnish is poured into an upright glass vessel large enough to contain the lamp. A common drinking glass is as good as anything, if large enough to admit the lamp. In pouring out the varnish, care should be taken not to disturb any sediment which may be at the bottom, and if not quite clear it should be filtered, as it is of the greatest importance to avoid any small floating particles, which would cause spots or streaks on the finished surface.

All being ready, if the varnish is to dry bright, *i. e.*, for colored lamps, etc., switch on the current to the lamp for a few moments, so as to render it slightly warm. Then turn it off, and taking the glass of varnish in the left hand, raise it under the lamp until the whole globe is immersed. If the lamp is in any kind of rigid fitting, it will be very easy to immerse it, but if it is merely hung on a couple of wires, it will require the aid of a little instrument, consisting of a forked piece of wood, to push the globe down into the varnish. As soon as the varnish entirely covers the globe, lower the glass with one steady movement, so that the draining off the superfluous varnish shall be commenced in one even wave all over the globe. Any hesitation or pausing in the motion of the glass will be almost sure to cause a line on the finished lamp.

As soon as the tumbler of varnish is quite clear from the lamp, turn on the current again, and leave it running, while several more lamps are being done. When about twelve lamps have been varnished, the first will be ready to come off. But a little care must be taken till the lamp is quite cold, as some varnishes will finger mark readily at this stage. If the varnish is to dry "matt," the lamp should be plunged quite cold, and no current should be put into the lamp till the varnish has chilled all over, then a little warmth will aid the drying, and will also harden the varnish. Almost any color can be given to the varnish by the simple use of Judson's dyes, which will readily mix with the varnish and impart their characteristic tints.

Blue is the most difficult color to arrive at satisfactorily, as the dye does not seem to blend so well with the varnish as the other colors, and, besides, the color is spoilt by the yellow tone of the light. To avoid this part of the difficulty, the lamps which are to be used blue should be run as *hot* as possible, while those for red or yellow colors may be comparatively cool, the yellow especially so.

It goes without saying that all the testing of the lamps must be finished before the varnishing is commenced.

A pleasing effect is sometimes produced for purely decorative work by using a little dye with the "matt" varnish.

## ALEXANDER SIEMENS.

Mr. Alexander Siemens, whose portrait we publish this week, was born, says *The Electrician*, at Hanover in 1847, and was educated at the Lyceum and Polytechnic College there. In 1867 he came to England, and worked for a short time at the telegraph factory of Messrs. Siemens Brothers, at Woolwich. In the following year he went to Berlin to study at the university, and remained there until 1870, with the exception of filling a temporary engagement, during which he assisted in constructing the Indo-European telegraph line from the Persian frontier to Teheran and in laying the Black Sea cables at Kertch and from Sukhum Kale to Sotcha. He was next called upon to serve his country in the Franco-German war, and was present at the siege of Metz, and afterward, under Prince Frederick Charles, joined in the operations against Orleans. He was wounded at the battle of Beaune la Rolande, and for his distinguished services in the field received the Iron Cross.

At the conclusion of the war Mr. Siemens was able to continue his scientific studies, and coming to England became a pupil of the late Sir William Siemens. In 1873–74 he was conducting experiments for Sir William, at Birmingham, with a rotary furnace to produce wrought iron and steel direct from the ore. In 1875 Mr. Siemens joined the cable ship Faraday and took part in several cable laying and repairing expeditions. While the ship was stationed at Halifax, N. S., he built some blast furnaces at Londonderry, N. S., for the Steel Company of Canada, and superintended the erection of a rotary furnace at Pittsburg, Pa. Returning to England in 1877, he was employed in erecting regenerative gas furnaces for various purposes in different parts of England, among them being the first continuous working tank glass furnace erected in this country. In 1879 he became actively engaged in electrical work for Messrs. Siemens Brothers, and had to

ALEXANDER SIEMENS.

do with some of the first electric light installations, such as those at the Albert Hall, the British Museum, the Albert Docks and the Blackpool Promenade. He also laid down an electric light plant at Godalming, the first town in England to so light all its thoroughfares and supply current to private consumers.

Mr. Alexander Siemens became a director of Siemens Brothers & Co. some time ago, and is now the only director residing permanently in England. In 1892 he contributed a paper to section G of the British Association at Edinburgh, on "Electric Locomotives on the City and South London Railway." He has been for many years a member of the Institution of Electrical Engineers, to which body he has contributed several papers of great interest to the profession, the most recent being that read on February 11, 1892, upon "Some Experimental Investigations of Alternate Currents." He was elected a vice president of the Institution four years ago, and is president for the year 1894.

## STORAGE BATTERY TRACTION AT WASHINGTON, D. C.*

By George C. Maynard.

Storage batteries have been weighed in the balance and found—*too heavy*. An honest man held the scales. Geo. W. Pearson is one of the best all-round street railway men in the United States. For nine years he has been president and active manager of the Metropolitan Railway, in Washington, D. C. During that period the necessity and the possibility of procuring a substitute for horse power for the propulsion of street cars has been one of the most important and pressing subjects he has had to consider, and he has given it the most careful and thorough study. Every known method has been investigated. These investigations led Mr. Pearson to a belief in the truth which everybody realizes and all disinterested persons admit, that the ideal motor is one which will make every car independent of all the others.

The Metropolitan Railroad (not counting several branches) is a double track road five and one-half miles long. It begins on the hills above Georgetown and ends in the eastern section of the city, a mile beyond the capitol. It runs through the principal business and residence sections of the city and passes the capitol and eight of the principal government buildings. The travel on the line is irregular, and at times exceedingly heavy. There is not a hundred feet of level track in the whole road. The grades range from two and one-half to five per cent., and there are forty-two curves, many of them very sharp. The sharpest curves are on the heaviest grades.

The use of a cable under such conditions was manifestly impracticable; the trolley system was prohibited by public opinion and a law of Congress; steam was out of the question; the proposition to use compressed air was an intangible scheme. On March 5, 1889, a special act of Congress declared that the use of horses should cease two years thereafter.

These facts pointed to storage batteries as most likely to furnish available power. Out of ten chaotic years of bitter contests and wasteful litigation over the rights of rival claimants to the invention, there came fair prospect of commercial utility backed by strong assurances from men of good judgment and sincere purpose. Some of the most competent electrical engineers in the country unhesitatingly declared their conviction that street railways could be successfully and economically operated by this system.

In the summer of 1889 Mr. Pearson and his associates determined not to add one more to the long list of trifling experiments, but to operate their road with storage battery cars if it were possible. At the outset they engaged the services of the well known electrical engineer, Mr. C. O. Mailloux, of New York, who had made a special study of accumulators ever since their introduction, to design a suitable plant and superintend its construction and operation. With him came Mr. F. H. Chamberlain, a practical electrical expert who had had a long and varied experience in work of this character. He has had charge of the Metropolitan power house and all the details of the work during the entire time it has been going on.

In the course of four months after the undertaking was started the first car was put on the road. Experimental trips were made at night after the day's traffic was done. With a fair load of the company's officers and directors a speed of 15 miles an hour over the whole line was attained and the prospects of success brightened. Additional cars were equipped, and, early in 1890, several were put on the road for regular service, sandwiched between horse cars and running at a uniform rate not exceeding six miles an hour. The fact that they were limited to this slow speed when they could easily go much faster was a trial to the ambitious motormen, who were disposed to regard their position as quite superior to that of the car horse drivers. Passengers patronized the new cars and the public watched their progress with much interest. Popular opinion turned in their favor, and for a while there was frequent expression of the opinion that the problem of rapid transit in large cities was solved. Still the months ran on into years and the horse cars were not displaced. Then there began to be surmises that the Metropolitan Company was only trying to gain time by making a show of changing its system, and did not really intend to make the use of storage battery motors permanent, even if the scheme proved feasible. As time went on the motors began to show signs of weakness, being frequently seen slowly laboring up the grades with a long line of horse cars behind them, and now and then blocking the road with a flat refusal to move another foot. In such cases their excessive weight precluding the possibility of removing them from the rails, the horse cars were jumped around them until relief could be obtained, when the proud-spirited motorman was compelled to resign his command to a plebeian driver, and four of the strongest horses from the stable would ignominiously drag the lumbering old ark back to the seclusion of the power house. As many as four cars were stalled at one time. But this was not altogether discouraging, for while the result of the trial of the first storage battery was not successful, the respective promoters of nearly a dozen other schemes stood ready to guarantee that their batteries would do the work. Every one of these was given an opportunity to demonstrate the truth of their claims, and nine different styles of accumulators were tested. The company provided every facility for charging and operating the batteries, and allowed the experts of each company to personally supervise the operations and to show what they could do.

An inspection of the Metropolitan Company's power house and facilities for operating the battery cars clearly evidences the seriousness and determination with which Mr. Pearson undertook the work. The buildings are substantial, spacious structures, erected especially for the work. The boiler house is 50×60 feet and contains three Campbell & Zell's 200 horse power boilers set with Murphy's mechanical stokers and provided with appliances of the most approved and efficient character. The engine and dynamo room is 65×85 feet. There are three Wright tandem compound non-condensing engines of 230 horse power each in place, with foundations laid for a fourth engine of the same size. The principal dynamos are Thomson-Houston 160 kilowatt machines, capable of developing a current of 220 volts and 800 amperes, and a number of auxiliary machines provided with ingenious appliances for coupling them in various combinations afford facilities for supplying any desired current. The station is equipped with an exceedingly complete outfit of the best Weston testing and measuring instruments.

The battery house is 85×122 feet, two stories high. The floors are built of cement, laid on heavy iron supports, and are thoroughly acid proof. The arrangements for convenient and rapid handling of the batteries are most complete. This building faces the street along which the main track runs, while the engine and boiler houses are in the rear. By a loop from the main track the cars are run through the building, stopping on a platform, on each side of which is an elevator operated by two Thomson-Houston 15 horse power motors. The batteries arranged in racks, after being charged in the upper story of the building, are lowered to the side of the car, where the exhausted cells are quickly

* *The Electrical Review*, New York.

drawn out and the fresh ones put in. This equipment affords facilities for handling 180 sets of accumulators, and the building has space for twice that number. The plant in its present condition can easily charge 60 sets of accumulators at one time. In addition to the extensive and substantial character of the buildings above described, an item on the company's cash book of $387,000, expended in constructing the plant and operating the motor cars, substantiates the statement that the company has left nothing undone to work accumulators for all there is in them. Forty cars were built especially for this work, and 15 of them were fully equipped for service. The highest number of cars ever out on the road at one time was 10. At the commencement of the experiments, motors and dynamos, especially designed by Engineer Mailloux, were built for the company, but a little later those made by the Thomson-Houston Company were tried and found more satisfactory. Two 15 horse power motors, weighing 1,690 pounds each, were used on each car. The Baltimore Car Wheel Company's improved storage battery truck added 2,000 pounds, and the total weight of the car thus equipped was six and one-half tons. The horse cars on the Metropolitan line weigh about two tons each.

At first much difficulty was experienced with the regulators, but improvements devised by Messrs. Mailloux and Chamberlain soon remedied this. The arrangements of circuits to secure five distinct rates of speed were as follows:

1. Both batteries in multiple, motor fields and armatures in series.
2. Both batteries in multiple, motor fields in series, armature in multiple.
3. Both batteries in series, motor fields in series, armature in multiple.
4. Both batteries in series, motor fields and armature in multiple.
5. Same as 4, with 5-10 shunt across the fields.

To sum up the elements of the undertaking, the following points are clear. Steam plant perfect; dynamos and accessories, comprising the charging machinery, everything that could be desired; facilities for handling the batteries admirable; cars and their motor equipments of the best; the track newly constructed by the Johnson Company, of 62 pound improved grooved girder steel rail and in excellent order; the best professional skill obtainable; intelligent, skillful and energetic business management—all essential elements to success—and success must have been attained had the performances of the accumulators been equal to the company's expectations and the promoter's promises. As the records stand, failure must be written for every one of them. They started out with hopes and ambitions, but hopes were doomed to disappointment, while ambitions and amperes disappeared together.

The companies whose accumulators were tested will be designated by number.

No. 1.—The car was equipped with 120 cells, weighing 27 pounds each, and the trial lasted about seven months. The longest run made on one charge was 27½ miles. When the cells were new they were given a charge of 100 ampere hours and the discharge was 86 ampere hours, but this creditable performance was not sustained. After being charged and discharged a few times the efficiency fell steadily and rapidly, and after a service of 1,327 miles the cells were entirely exhausted and worthless. This feature of rapid depreciation was experienced with every battery used. In no instance was the electro-motive force allowed to fall below 1·5 volts per cell.

No. 2 was one of the most promising accumulators experimented with. It was furnished and its use superintended in person by one of the best scientific and practical electricians in the country. Ninety-six cells, 32 pounds each, comprised the outfit for a car. It required 250 ampere hours to charge these cells, and, in return, they gave just 43 ampere hours' service, never making more than six and one-half miles run on one charge. At the end of their 365th mile they were dumped into the scrap pile.

No. 3 was another serious disappointment. One set of 96 cells, 33 pounds each, was first procured, and its service proved so satisfactory that the company ordered equipments for 10 additional cars. The latter were failures. The first was charged in 100 ampere hours, discharged in 86 ampere hours and ran 21¼ miles on one charge. The record of the others shows 420 ampere hours' charge and 43 ampere hours' discharge, with a run of only nine and one-half miles. The total service of the best car on which this system was used was 660 miles. After this discouraging experience there came with serene confidence and high hopes, the promoters of

No. 4.—Ninety-six 42 pound cells were used. After carefully and faithfully giving them a charge of 450 ampere hours, the car was put on the road, made a fitful and feeble run of exactly 5,000 feet, and never turned a wheel again. Horses hauled the car home, and the accumulator expert left the city before day-break.

No. 5.—The staying qualities of this battery were vouched for by business managers and electricians of high character and long experience. There were 112 cells, 42 pounds each in a set. Their record in ampere hours is 100 charge to 86 discharge for the first few trips, after that they fell away rapidly. Twenty-two miles was their longest single run and 3,243 miles ruined them.

No. 6.—The operation of this battery was superintended by two experts representing its manufacturers. After receiving a charge of 250 ampere hours it rewarded its owners by discharging itself in 26 ampere hours, getting the car three miles away from the power house before breaking down. It was never tried again.

No. 7.—One hundred and ten cells, 32 pounds each, ampere hours 100 charge to 86 discharge, longest run 22 miles, total service before breaking down 2,227 miles.

No. 8.—Ninety-six cells, 44½ pounds each, ampere hours charge 100, discharge 86, longest run 22½ miles, total service 4,123 miles.

No. 9.—One hundred and twelve cells, 32 pounds each, ampere hours charge 100, discharge 43, longest run 10½ miles. These batteries failed after running 70 miles.

The best batteries tested did not stand more than 27 days' actual service, and the cost of running the cars by five of the most serviceable batteries ranged from 12½ cents to 37 cents per car mile. The cost of running horse cars on this line is about six cents per car mile.

The causes of failure are numerous and not easy to enumerate. Buckling plates, excessive heating, loosening of active material, short circuiting of cells from various causes, general rapid deterioration of positive plates, sudden and sometimes unaccountable loss of current, destruction of connections by acid, are some of the more marked eccentricities of the accumulators. There is a lingering suspicion that they are safer in the laboratory of a professor of chemistry than on a jolting tram car.

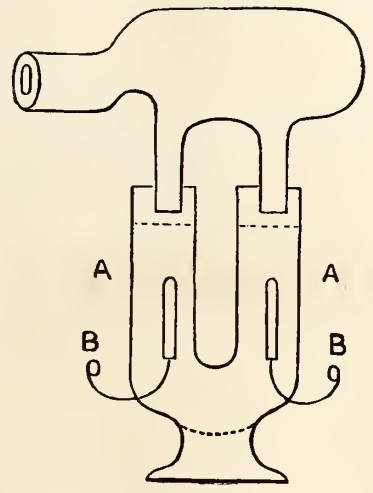
After more than four years of intelligent and persevering effort the undertaking has been suspended. The motionless machinery, the idle cars and valueless batteries, the enormous hole in the company's bank account are full of significance. Every available means to attain success was tried and failed. The experiment has settled many vexed questions, exploded some humbugs and will be of great value to all persons interested in street railroads. It has made it clear that, up to the present time, science and art have not produced a storage battery capable of supplying power to practically operate such roads as the Metropolitan.

Still the result does not justify absolute condemnation of storage batteries for railroad use, nor destroy hope of an independent railway motor. Such a motor is demanded by public need, the inventive genius of the world is challenged to produce it, and there is a growing faith that, somewhere in the conserved forces of the universe, there is a power which shall wipe the usightly and obstructive trolley lines off the face of the earth, shall bury the power-wasting cables in their own grave, and turn the faithful car horse out to the enjoyment of green pastures and well-earned days of rest.

## AN ELECTRIC BLOWPIPE.

By H. N. WARREN, Research Analyst.

THE difficulty of manipulating with hydrogen gas in conjunction with oxygen when high temperatures are desired has for a long time past induced experimenters




to substitute for the former coal gas. This agent, although suitable for lime light illumination, is far inferior as regards temperature to the use of pure hydrogen. During the past season the author has had occasion in several instances to test the efficiency of the two mixtures. Several refractory substances, melting readily by the aid of the pure oxyhydrogen, were observed to obstinately refuse liquefaction at all when subjected to the influence of the latter compound; a blowpipe thus fed by a mixture of coal gas and oxygen, even when both at the same pressure, is very weak as regards its action, the most serious drawback being the difficulty of obtaining a flame uniform; first the outer part of the flame being hottest, then the innermost. These difficulties will be found altogether obviated by using the electro-oxyhydrogen blowpipe, as shown in the accompanying diagram, which, after several different constructions as regards pattern, appears thus in one of its simplest and most effective forms: A A, consisting of a glass U-tube of suitable dimensions mounted upon stand and furnished with interior platinum plates; B B, in contact with acidulated water, which is introduced into the apparatus before using the same, the blowpipe in connection with the upper part allowing the gases to mix in the ordinary way. Thus is constructed the most effective blowpipe ever introduced to the scientific world; being perfectly automatic, of almost indefinite duration, and requiring no taps as regulators, the gases being evolved in exact proportion to reform water, while the flame is regulated at will by means of the electric current. By similar construction upon a larger scale an automatic furnace may be arranged.—*Chem. News.*

## A NEW FORM OF INFLUENCE MACHINE.*

By JAMES WIMSHURST.

IN April, 1891, I had the honor to submit to this meeting a very useful form of experimental influence machine, by means of which I was able to show that almost every combination of glass and metal, and also that plain glass disks, when moved and suitably touched, were capable of producing a flow of electricity.

It is one of those combinations, somewhat modified and extended, which I have now the further pleasure of bringing to your notice.

The machine consists of two disks of plate glass, each of 3 ft. 5 in. diameter and ¼ in. thickness, mounted about ¾ in. apart on one boss and spindle, This spindle is driven by means of a handle, and the disks rotate in one direction.

* Read June 23, 1893, before the Physical Society.

In the space between the disks are fitted four vertical slips of glass, two being situated on the right hand side of the machine and two on the left hand.

The vertical edges of the slips which come nearest the spindle are cut to an angle, leaving a rather wider opening at the circumference than at the center of the disk. Upon each slip is a brush, A, and also an inductor, the brush and the inductor being metallically connected; the brushes are made of fine wire, and touched very lightly on the inner surfaces of the disks. The glass slips slide into place by means of suitable grooves at their top and bottom ends; they may be removed and replaced readily at pleasure.

The essential parts are fitted together within a glass case, and in all respects the machine is so constructed as to be useful for experimental work. The limited size of the case causes the insulating distances between part and part to be small; hence the length of the sparks is reduced. All the surfaces are coated with shellac, and when the brushes are new and in proper condition, the machine is self-exciting.

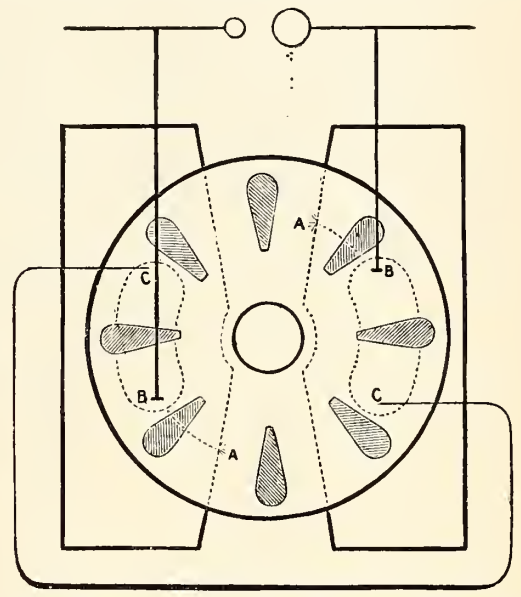
The charges are not subject to reversal when the terminals are opened beyond the striking distance, for then the whole of the induced charges pass by way of the neutralizing brushes, C, C. Another feature is that the neutralizing current may also be broken without reducing the excitement, but then the charges alternate from positive to negative with each half revolution of the disks.

An approximate measure of the efficiency of the machine is seen by the following experiments.

The glass throughout was held free from electrical excitement, and the disks were rotated 60 times per minute; the actuating cause was then removed, and the disks came to rest after making 47 revolutions. This measures the friction of the machine.

The disks were then similarly turned, but the electrical charges were allowed to collect; it was then found that the disks came to rest after 23 revolutions. The friction of the machine, therefore, is about equal to the repulsion of the electrical charges.

Leyden jars, having eight square inches of tinfoil in each coating, were then connected to the terminals,




A, A, brushes connected metallically to the inductors; B, B, collecting brushes connected with terminals; C, C, brushes connected with the neutralizing circuit.

and the terminals set 3½ in. apart; the disks were turned to the same number of revolutions and then left to come to rest, which they did after producing 80 sparks.

The disks were then turned and the number of sparks counted in relation to each revolution. This gave seven sparks of 1 in. length, five of 2 in., four of 3 in. and three of 4½ in. length.

Eight metal sectors were then added (total 112 square in. on each disk); with them the self-excitement becomes so free, that before any circuit was made, presenting the fingers to the disks caused electrical discharges.

When the circuits are made between the several brushes the disks appear to be seething with electricity, and the charges shoot out for a considerable part of their circumference, but chiefly at the top and the bottom, where they are not covered by the vertical glass slips, for the change of the charges from + to — takes place upon the disks just as they pass the edge of the slip. Improvements in this respect might be made, but the present arrangement has the advantage of giving permanence to the respective charges.

It will be noticed that strips of tinfoil are placed over the receding surfaces of the glass slips. They were intended to afford the means for collecting and carrying to earth any part of the charges from the inductors, but the earth connection has not been necessary.

When at work, the charges passing from the disks to the brushes may be heard some considerable distance; they resemble the beating of the floats of a paddle wheel.

The charges are, however, reduced about 25 per cent. by the addition of the sectors.

Further tests have been made by fixing a pulley 3 in. in diameter, to the overhanging end of the spindle, and suspending therefrom by a cord a weight of 15 pounds. The fall of this weight through 3 ft. produced 17 revolutions when the disks were not excited and 10 revolutions when excited. The same Leyden jars were then connected, and it was found that the fall of the weight through 3 ft. produced 28 sparks of 3½ in. length. Reducing this to the terms of work in relation to sparking length, and omitting friction of the machine, it will be seen that 1 pound weight falling through rather less than 12 in. produces a spark of 3½ in. length. It must not, however, be forgotten that a considerable amount of electricity is also passing by way of the neutralizing circuit.

[Continued from Supplement, No. 947, page 15137.]

# ALLOYS.*

By Prof. W. Chandler Roberts-Austen, C.B., F.R.S.

*Lecture IV.*†

The Japanese have long had the secret of the preparation of a series of alloys in which the precious metals are used in such a manner as to deliberately sacrifice the metallic luster, and, in the case of gold, even its distinctive color, for the sake of producing other definite effects. The brilliancy of gold and silver in their natural state is employed by this artistic nation merely to heighten the general effect of a design, and the result of centuries of patient labor is that the Japanese art metal worker possesses a series of alloys which rival the palette of the painter in range of tint. The nature of the alloys has already been fully described in the lecture to which I have referred, and I will, therefore, merely say that one class of them consist of copper alloys allied to the bronzes, but in which gold and silver replace tin and zinc. The history of their evolution would be most interesting to develop, for the wave of Indian colonization reached Japan in the sixth century of our era, and that would appear to be the earliest period at which such alloys could have been adopted for artistic purposes by the Japanese, "a race which possesses the artistic instinct in certain of its developments in a greater degree than any other in our time. With them the sense of decorative distribution and of subtile loveliness of form and color is absolutely universal, and expresses itself in every most ordinary appliance of daily life, overflowing, indeed, into every toy or trifle that may amuse an idle moment."‡ There are hundreds who will visit the cases of this museum and will bestow appreciative admiration on the Japanese wares, but there are very few who know how the varied effects are produced. Let me, therefore, direct attention to a few selected objects and photographs. Take the simplest case first. Here is a plate (specimen shown) of brown bronze. There is no attempt at producing effect by a raised surface; the artist has simply chosen a plate of bronze, some 8½ inches in diameter. He has cut a design into the plate and has inlaid that design with a black alloy; wherever he has scooped out the drawing of this beautifully graceful bird he has inlaid the alloy, which now appears bluish black, and he has taken a darker variety of the alloy and has deepened the effect of the wing and tail feathers, and has in that way produced exactly the effect of an Indian ink painting in a dark and comparatively light shade. Now, what are the alloys the Japanese use, and how is the color produced? The following analyses show the composition of the more important of them.

The first is called "shaku-do." It contains, as you will observe from Analyses I. and II.,§ in addition to about 95 per cent. of copper, as much as 4 per cent. of gold.

*Shaku-do.*

| | I. | II. |
|---|---|---|
| Copper | 94·50 | 95·77 |
| Silver | 1·55 | 0·08 |
| Gold | 3·73 | 4·16 |
| Lead | 0·11 | |
| Iron and arsenic | traces | |
| | 99·89 | 100·01 |

Mr. Gowland, an eminent authority on Japanese metal work, tell us that shaku-do has never been used for very large works. It has, however, been erroneously stated that a colossal statue, cast at Nara in the seventh century, is made of it. The quantity of gold is really very variable, and certain specimens I have analyzed contain only 1·5 per cent. of the precious metal. The next important alloy used by the Japanese is called "shibu-ichi," and the following are typical analyses:

*Shibu-ichi.*

| | III. | IV. |
|---|---|---|
| Copper | 67·31 | 51·10 |
| Silver | 32·07 | 48·93 |
| Gold | traces | 0·12 |
| Iron | 0 52 | |
| | 99·90 | 100·15 |

There are many varieties of it, but in both these alloys, shaku-do and shibu-ichi, the point of interest is that the precious metals are, as it were, sacrificed in order to produce definite results, gold and silver, when used pure, being employed very sparingly to heighten the general effect. In the case of shaku-do, we shall see presently that the gold appears to enable the metal to receive a beautiful rich purple coat or patina when treated with certain pickling solutions, while shibu-ichi possesses a peculiar silver-gray tint of its own, which, under ordinary atmospheric influences, becomes very beautiful, and to which the Japanese artists are very partial. These are the principal alloys, but there are several varieties of them, as well as combinations of shaku-do and shibu-ichi in various proportions, as, for instance, in the case of kiu-shibu-ichi, the composition of which would correspond to one part of shaku-do rich in gold and two parts of shibu-ichi rich in silver. The precious metals are deliberately sacrificed with a view to obtain a definite effect, a distinct tint that is in the patina, and if gold and silver are employed pure, it is only to heighten the general effect.

With regard to the use of pickling solutions, so far as I have been able to ascertain, they are made up respectively in the following proportions, and are used boiling:

| | I. | II. | III |
|---|---|---|---|
| Verdigris* | 438 grains | 87 grains | 220 grains |
| Sulphate of copper | 292 " | 437 " | 540 " |
| Niter | ... | 87 " | ... |
| Common salt | ... | 146 " | ... |
| Sulphur | ... | 233 " | ... |
| Water | 1 gallon | ... | 1 gallon. |
| Vinegar | ... | 1 gallon | 5 fluid drachms. |

That most widely employed is No. I. When boiled in No. III. solution, pure copper will turn a brownish red, and shaku-do, which, you will remember, contains a little gold, becomes purple. And now you will be able to appreciate the effect of small quantities of metallic impurity as affecting the color resulting from the action of the pickle. Copper containing a small quantity of antimony gives a shade very different from that resulting from the pickling of pure copper. But the copper produced in Japan is often the result of smelting complex ores, and the methods of purification are not so perfectly understood as in the West. The result is that the so-called "antimony," or shiro-me, of the Japanese art metal workers, which is present in some alloys, is really a complex mixture containing copper, lead, arsenic and antimony, so that a metal worker has an infinite series of materials at command with which to secure any particular shade; and these are used with much judgment, although the scientific reasons for the adoption of any particular sample may be hidden from him. It is strictly accurate to say that each particular shade of color is the result of minute quantities of metallic impurity, and a few examples will, I trust, make it clear that the Japanese arrange true pictures in colored metals and alloys.

The action of these solutions is remarkable. You have copper to which a small amount of silver and a small amount of gold are added. The amount of gold may be variable, and artificers often take credit for putting in much more than analysis proves to be present, but a small amount of gold, it may be only one per cent., is sufficient to entirely change the character of the copper, and when you come to treat it by pickling solutions, you get a totally different result from that which would result from the employment of pure copper.

The series of alloys known as shibu-ichi vary in composition. Sometimes it will contain one half silver and the rest copper, often only one-third silver, the bulk of the alloy being copper; but in all cases the alloys assume, either by handling, by exposure to ordinary atmospheric influences, or by pickling, a beautiful series of light and dark gray tints greatly admired by Japanese, who employ the alloy in almost all pieces of metal work. [The reader should refer to the report to which reference has been made, which gives the composition of a series of plates of metal, brass, shaku-do, shibu-ichi and copper, which were specially prepared to show the texture and tints of various metals and alloys employed by the Japanese. They are modern, and far from being the best examples which could be obtained, but they are, nevertheless, very instructive.]

One of them is a plate 18½ inches in diameter. It is not in the South Kensington collection, but it is so typical that it may as well be taken as an example as any other. A plain surface of copper has first been taken, the design has been drawn upon it, and each leaf or flower has been scooped out and undercut. The leaf or flower would then be made of a particular alloy, say purple shaku-do tipped with gold or red copper, and the whole design is fitted in like a puzzle, and the result is they build up a picture gradually, using colored alloys or alloys which may be colored by the action of a pickle, and they attain the result which is shown. The basis is a plate of copper. Here in one place there is a leaf which is not really raised, but a little sunk below the surface of the original plate. The only relief it possesses is obtained by hammering a light variety of gold over it. Then comes a red bud of su-aka, set with its golden points. Here is a shibu-ichi leaf, half of which is of red su-aka, and if you look closely afterward you will see the bird, or shaku-do, with all its feathers carefully drawn, and the lustrous effect of the plumage produced with really consummate skill by the use of fine lines. Then comes a shibu-ichi flower, with a golden center. This is typical of the work they do; however large or small it may be, they simply inlay these colored alloys, using generally a somber base. The beautiful vase, No. 30, 1886, in the South Kensington collection, has all the typical alloys.

The Japanese do not merely trust to obtaining effects by high relief, as is the case with this plate; very often they employ a darker alloy for producing the effect of painting on metal, so to speak, in a very remarkable way. There is one example in Mr. Huish's collection, a knife handle, which presents the effect of a duck's back and wings in comparatively high relief, with his neck under water. He is a shaku-do purple duck, plunging through silvery-gray water, but his body is in high relief, his neck is of a different *nuance* of tinted shaku-do to the rest of his body, and it is so beautifully let in that it is only in certain lights that you can see it at all, but it produces exactly the effect of the duck's neck being below the surface of the water. I have not that specimen here, but I have in a sword hilt, also from the collection of Mr. Huish, some tiny minnows, each about one-sixteenth of an inch, with minute gold eyes, swimming up a shibu-ichi gray stream, the effect of their being actually below the surface of the water being suggested with marvelous skill. I think at present no European artificer could obtain such a result as that, as it shows the most beautiful effects, not merely of texture, but brilliancy and transparency. The color effect they produce by the use of the pickles—the composition has been already given—but many of the extremely valuable old Chinese bronzes have acquired their tint simply by long exposure to atmospheric influences. If you look, for instance, at No. 160 in the South Kensington bronze cases, it is a Chinese duck of about one foot across, if I recollect rightly, purchased about 1876, and it has a green patina, indicating extreme old age, and although my friend Mr. Gowland says the attribution of it on the label to the third century is inaccurate, still it is an extremely old specimen of bronze, which has acquired its green patina by perfectly natural causes, unaided by artificial treatment, such as the Japanese always employ in more modern work. Again, there is No. 148, a green gourd, in the South Kensington collection, and No. 79, a vase in the form of two cups, base to base, a beautiful mottled red on a green patina, and I think in this case the red is produced by heating and not by pickling. Then if you look at No. 224 in the museum, you will see a bronze fish with scales inlaid with silver, which is very instructive.

The vase, No. 120A, 1878, is given on account of its suggestiveness and the simplicity with which the effect is produced. The upper part is of light bronze and the globular portion consists of a series of bands joined with silver studs or rivets. The uppermost band is of red copper, the next is of liver colored bronze, the next has a brilliant green patina of carbonate of copper, and this is followed by another bright red layer, and then by one of light bronze, the base being either shibu-ichi or silver.

There is one other mode of treatment which I have specially studied, but the South Kensington collection contains only two examples of it, a pair of vases, one of which is a singular combination of banded alloys. The characteristic alloys employed by the Japanese are taken in thin sheets and soldered together. Conical holes are then drilled partly through the mass, so as to penetrate different layers of strata of the mass, and when the whole is beaten flat, of course different layers will come to the surface. Another method consists in raising prominences on the front of the plate by punching the back, and these prominences are then filed flat, producing banded effects of great beauty and complexity. These alloys are often introduced into the tiniest work. A single bead half an inch in diameter may contain hundreds of layers. The names mizu-nagashi (marble) and moku-me (wood grain) are given to the chief varieties. This pair of vases is one of the few examples in this country. It is not particularly good in form, but is of great merit as regards the manipulative skill displayed in its production. The neck, band, and foot are of shaku-do inlaid with gold, while the body of the vase is of mizu-nagashi, consisting of alternate layers of shaku-do and red copper, and there is a silver panel bearing a bird beautifully wrought in gold and colored alloys beaten into the silver. The band round the center is of shaku-do, which has been wrought with fine indentation so as to produce a singularly faithful resemblance to leather.

The South Kensington collection also contains an interesting vase, No. 72, 1889, of old Japanese work in marbled bronze, but the marbling is in the patina alone, for the vase is of solid bronze, and is not made of layers, as in the case just described.

### GOLD.

With regard to alloys of gold, I do not think that in modern times we make nearly enough use of the very old alloy *electrum*. It occurs native, and was originally regarded as being a distinct metal, of the same order as gold or silver. Lovely coins were struck from nuggets of it B. C. 700. It was prepared artificially also, as is shown by the following sentence: "As when gold is fused around silver by an experienced man, whom Hephaestus and Pallas Athene have instructed in all kinds of arts, that he may execute graceful works, so did the goddess pour gracefulness around his head and shoulders."* Ultimately, the authors of the middle ages applied the word electrum to yellow bronzes, and more especially to brass. I have one analysis of the true, gold-silver electrum, a specimen in the South Kensington Museum.

No. 28.—A Relic Shrine, or "Stupa," in four parts (incomplete). Gold repousse and chased with conventional ornament in bands. *Burmese.* Discovered in leveling a Buddhist temple at Rangoon in April, 1885. H. 15 in., diam. 12¼ in. 02755.

*Analysis.*

| | |
|---|---|
| Gold | 72·02 |
| Silver | 22·96 |
| Copper | 5·24 |
| | 100·22 |

This leads me to speak of the extraordinary effect of metals on gold, effects which we are only now beginning to examine. Take, for instance, the action of aluminum on gold. An alloy containing 90 per cent. of gold and 10 per cent. of aluminum is a brilliant white, but if the amount of aluminum be doubled (really 23 per cent.), then a brilliant purple alloy, ruby colored in its crystals, is obtained; and from the yellow gold and the gray aluminum we have the most brilliantly colored alloy which is as yet known. Greenish gold is produced by adding 14 per cent. of silver to pure gold, and blue gold by the presence of a little iron.

### SILVER.

The peculiar grayish tint often seen on the surface of silver wares or on that of silver copper alloys, and known as "oxidation," is readily produced by immersing the articles in a hot solution of sulphide of potassium.

There is, however, a delicate violet tint which may be imparted to silver by converting its surface into a thin layer of chloride, and then allowing the action of light to stain the chloride violet. Messrs. Christofle† long ago pointed out that this might be done, and Messrs. Tiffany, of New York, have recently produced some very beautiful articles in this violet tinted silver.

A little specimen of their work has been placed in the museum. It has a damascened ornament produced by protecting certain portions of the chloridized silver from the action of light.

Old work in *niello* hardly comes within the limits of this lecture, but it may be mentioned that M. Lucien Gaillard, of the well known firm of silversmiths of Paris, has recently produced some articles of great beauty in malleable sulphide of silver.

### NICKEL.

The specimens of metal work analyzed from the Persian and India collections do not contain more than

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† Some of the particulars contained in this lecture were given in a lecture delivered at South Kensington Museum in 1892, and some portions, relating to Japanese art metal work, formed the subject of a paper read before the Applied Art Section of this Society, which appeared in the *Journal* June 30, 1890.

‡ Sir. F. Leighton. Presidential address National Association for the Advancement of Art. "Transactions," 1888, p. 22.

§ Analyses Nos. I. and III., both on sword ornaments of the finest quality, are by Mr. Gowland, of the imperial Japanese mint, at Osaka; Nos. II. and IV., by Professor Kalischer, "Ding. Polyt. Journ.," ccxv., 93.

* Sulphate of iron may sometimes replace verdigris.

* Od. vi. 232-5, quoted by Schliemann, 258 Ilios, probably manufactured electrum.

† "Comptes Rendus," vol. 73, 1874. 1019.

small quantities of nickel, some $\frac{3}{10}$ per cent. is all that could be found. This is somewhat remarkable, for there is undoubted evidence of the use of wares in nickel-copper alloys in India. The late Dr. Walter Flight examined several coins of kings of Bactria, of dates varying from 150 to 246 B. C., and found that they contained nearly the same amount of nickel as the modern nickel coinage of European nations—75 per cent. of copper, and 25 per cent. of nickel. One of the specimens analyzed by Flight, a coin of Euthydemus, was found to contain:

| | |
|---|---|
| Copper | 77·585 |
| Nickel | 20·038 |
| Cobalt | 0·544 |
| Iron | 1·048 |

General Cunningham, in his elaborate paper on the coins of Alexander's successors in the East, inclines to the opinion that the copper-nickel alloy must have come from China. He points out, however, that Quintus Curtius mentions that near the junction of the five Panjab rivers, Alexander received from the Oxydracæ and Malli a present of 100 talents of white iron (*ferri candidi*), which could not have been tin, as that metal was well known to the Greeks, and it may very probably have been a white alloy of nickel and copper.

Analysis No 59 in the report was made on a chopstick case, of modern Japanese workmanship, which was found to contain 6·14 per cent. of nickel.

No. 59.—Chopstick case. *Modern Japanese.*

*Analysis.*

| | |
|---|---|
| Copper | 65·88 |
| Arsenic | cons. trace |
| Lead | 0·33 |
| Bismuth | trace |
| Iron | 0·37 |
| Nickel | 6·14 |
| Cobalt | 0·50 |
| Zinc, by diff | 26·78 |
| Gold | trace |
| Silver | trace |
| | 100·00 |

This sample, from my own collection, was an electroplated one, and was covered with a coating of silver, which was removed prior to analysis. The surface scrapings contained much silver. The color of the above metal was nearly white.

ANTIMONY.

I have already called attention in the analysis No. 40 to the presence of 2 per cent. of antimony in a variety of brass. At the present day we only know antimony as a brittle metal, but Berthelot* analyzed a fragment of a Chaldean vase, which proved to be of pure antimony, so that the ancients must have known some method of making this metal malleable.

Dr. Gladstone† has recently shown that some beads found by Dr. Flinders Petrie in Egypt are of antimony.

Viewing the materials at the command of the art metal worker as a whole, the point I want remembered is this, by the time the elder Pliny, the naturalist, wrote in the first century of our era, and described as well as a cultured gentleman with scientific tastes could the nature of early metallurgy, that industrial art was itself really far advanced, and the art metal worker had excellent materials, mainly bronze, at his disposal. But the artist was far in advance of the metallurgist, if we only judge by the articles of the most common use found in Pompeiian homes, ordinary kitchen utensils which, as Sir Frederick Leighton says, exhibit an amazing wealth of idea and a high level of executive merit, "each bowl, each lamp, each spoon almost, is an individual work of art, a separate and distinct conception, a special birth of the joy of creation in a genuine artist, the chief characteristic of Pompeiian work being the absence of any ugly thing."

If art metal work is to be revived in this country, it will be well to remember that, while in the time of Pliny the art metal worker produced beautiful things with few metals and alloys, his successor of to-day makes but scanty use of the wealth of materials at his command. In this direction France has little to teach us. Take, for instance, the bust representing *Gallia* in the Luxembourg. It was modeled by M. A. Moreau-Vauthier, and executed by M. L. Falize. The face is of ivory; over a chain armor in black silver there is a breast plate in two shades of gold, enriched with topaz and emerald. The helmet of gold is relieved by black niello, and there are two straps of brown bronze, which well represent leather, hung from the helmet. The work is excellent, but how greatly the effect might have been heightened, and the interest in the work deepened, if the artist had only employed the Japanese series of alloys. One artist alone, Alfred Gilbert, has employed them, and, of course, with great skill and effect; and as in him the nation possesses a sculptor whose work is equal to the best days of the Italian Renaissance, we must look to his school for advance in this direction. We may then remove the reproach that we are still far behind the Oriental metal worker. It would appear that neither the purple shaku-do, nor the gray shibu-ichi, is suitable for striking into medals that require even moderate relief; at least, I failed to produce satisfactory medals in either of these alloys, for even the small proportion of gold which, in shaku-do, is added to copper, very materially hardens the copper. Both alloys may, however, be used either in sheets or cast into moulds. The Japanese do use them cast, and it may be well, therefore, to conclude this lecture by a brief account, but little more than an outline, of the method of casting known as *cera perduta*, which suggests an infinite variety of applications for these interesting alloys.‡ It must be imagined that the bust has been modeled in wax (*b*) on a core of plaster (*a*). The drawing is a little too picturesque, for it is the outer layer of wax which determines the actual form assumed by the cast metal. The wax model would have rods of wax (*e*), (*e'*) affixed to it, and at least two rods placed in the position shown at (*f*), (*f'*). A funnel-shaped rod of wax would be placed above the head, so as to leave the opening or "get" (*c*) through which the metal would be poured. The bust with the rods of wax would then be covered with a mass of plaster (*d*) shown by the cross-hatched lines, and when the mass is firmly set and dry the wax would be melted away by surrounding the entire mould with a fire. The wax will then pour out from the lower orifices (*f*), (*f'*), leaving an empty space wherever it had been. There must be suitable supports to prevent the shifting of the core. The ducts (*f*) and (*f'*) are then closed by plugs, and bronze or other metal is then

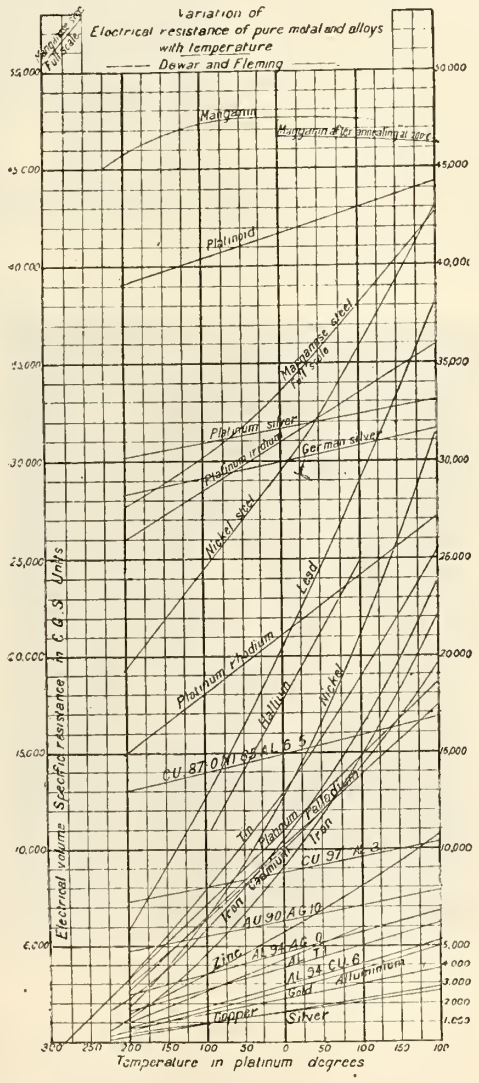
poured in through the "get" (*c*), filling the spaces left by the wax. The openings (*e*) and (*e'*) serve to allow the air to escape, but they become filled with molten metal, and the rods thus produced have to be cut away from the finished bust. It will be evident that the cautious removal of the plaster of the mould, shown by the cross-hatched lines, will leave a metallic bust in the form of a thin shell investing the core (*a*).

The adoption of this process should afford abundant scope for the extended use of Japanese alloys, for which I have so long and so persistently pleaded.

LIQUID AIR.

PROF. DEWAR lectured recently at the Royal Institution upon "Some Scientific Uses of Liquid Air."

Prof. Dewar said that the chief scientific use of liquid air consists in the facilities it gives for studying the properties of matter under the excessively low temperature yielded by its employment. When Faraday was working in that Institution in 1823, with such powers as were then under his command, he may be said to have been limited to the study of the specific gravities alone of bodies at a low temperature. By




means of solid carbonic acid he obtained the greatest cold then possible for the liquefying of gases, but at the present time we are in a better position.

He added that during the recent summer Prof. Liveing and himself had continued their work on the optical properties of certain bodies at low temperatures, and Prof. Fleming and himself had done the same in relation to the electric conductivities of metals under the influence of extreme cold. The result of the first series of researches had been to confirm the law of Gladstone, by the results set forth in the following table:

*Refractive Indices of Liquid Gases.*

| | Index. | Ref. constant. | Ref. molecular. |
|---|---|---|---|
| Oxygen | 1·2236 | 1·989 | 6·364 |
| Ethylene | 1·3632 | 0·626 | 17·528 |
| Nitrous oxide | 1·3305 | 0·268 | 11·587 |
| Nitrogen | 1·2053 | 0·223 | 6·300 |
| Air | 1·2062 | — | — |

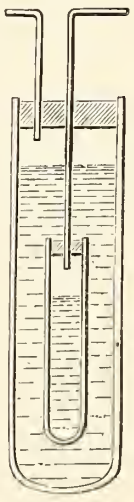
Law of Gladstone, $\frac{\mu - 1}{D}$ = constant.

The diagram shows the result of the latest experiments of Prof. Dewar and Prof. Fleming on the electric conductivity of metals at very low temperatures. They all point to the conclusion that at the zero of temperature all metals would become perfect conductors.

When speaking of the great impermeability of a high vacuum to heat, he drew attention to a simple method of demonstrating it designed by Crookes. Two thermometers were fixed side by side, the bulbs of each covered with similar glass jackets, in one jacket of which was a high vacuum, and in the other common air. He then placed the bulbs of the thermometers in hot water, and the liquid employed rose much more rapidly in the air-jacketed tube than it did in the other.

In his own experiments it had been found convenient to use mercury vacua, and the question had arisen, "How long does it take for the vessel to become filled with vapor of mercury?" this being important in relation to the action of mercurial pumps. It takes a very short time indeed to saturate an ordinary bulb with vapor of mercury from the liquid metal, and mirror after mirror may be brought down upon the interior of the bulb by the local application of liquid air outside. Frozen mercury will scarcely give traces of a mirror. If two vacuum bulbs connected by a short tube one-eighth of an inch in diameter be used, with mercury in one of them, and if the vapor be then thrown down in the other by freezing, it takes a long time afterward for the mercurial atmosphere remaining to get into a state of equilibrium; in fact, the power of depositing mercury in the bulb free from the liquid is almost stopped at first, unless a drop of the mercury is allowed to enter it, upon which a mirror can then be instantly produced by sufficient cold. In a closed vessel containing air, a frozen mercury mirror rapidly disappears when the cold is withdrawn When extreme cold is applied to a bulb containing nothing but vapor of iodine, the iodine comes down where the cold is applied, as a violet deposit. A faint electrical discharge will go through such a bulb, but not through one first filled with vapor of mercury, and then chilled; the spark then seems inclined to go anywhere but through the bulb. These points were all illustrated by experiments.

In solidifying common air, Prof. Dewar took two large vacuum-jacketed glass test tubes, as in the accompanying cut, the smaller one placed inside the



larger, and both containing liquid air. Each vessel had its separate tube communicating with machine air pumps in the laboratory, where the pumps are driven by a gas engine. After a time, what with cold produced by the rapid evaporation of the liquid air in the outer tube and what with the cold produced in the liquid air in the inner tube by its own evaporation, and what with the protection from outside warmth by the two vacuum jackets, a button of solid air looking like ice is at last obtained at the bottom of the inner tube. It quickly goes back into liquid air when the pumping ceases. This experiment was tried three times before it succeeded, and it answered only with freshly liquefied air. Too much of the nitrogen had boiled off from air liquefied before the lecture and preserved to some extent in jacketed glass flasks covered with carbonic acid snow. Oxygen has not yet been frozen, except when mixed with a large quantity of nitrogen. As the liquid air grew denser before freezing striæ were seen in it. The lecturer explained a method of performing experiments relating to heat with liquid air. In the first place, he showed that for several minutes at a time, while in vacuum-jacketed vessels, it is practically a stable liquid, from the few bubbles of it in gaseous state given off in the time and rendered visible by collection in an inverted glass tube with its open end in the pneumatic trough. Then, by dropping into the liquid air a piece of platinum or a little mercury charged with a known amount of heat, followed by others, known increments of heat may be communicated to the liquid.

The effect of great cold upon the cohesion of metals he had only been able to examine tentatively, but in every case tried the tensile strength had been increased. Iron at −180° C. has twice its normal tensile stress resisting power as shown in the following table, for which he would scarcely hold himself responsible, because his testing apparatus is not yet perfected. The jaws of

* "Ann. de Chem. et de Phys.," xii., 1887, p. 135.

† "Proceedings of the Society of Biblical Archæology," March, 1892.

‡ A sufficient account of this method applied to the casting of medals is given in the Mint Report, 1885, p. 25.

the machine had to be immersed in liquid air, of which they had used gallons during the experiments.

*Breaking Stress of Metals.*

| | 15° C. Tons per sq. in. | −180° C. Tons per sq. in. | 15° C. Elongation per cent. | −180° C. Elongation per cent. |
|---|---|---|---|---|
| Copper | 22·3 | 30·0 | 6·8 | 13·4 |
| Iron | 34·0 | 62·7 | 8·2 | 4·7 |
| Brass | 25·1 | 31·4 | 35·5 | 32·2 |
| G Silver | 38·3 | 47·0 | 10·7 | 20·4 |
| Steel | 35·4 | 60·0 | 29·4 | 19·5 |

The lecturer produced a card painted red with mercuric iodide, and wherever he drew a pad of cotton wool across it dipped in liquid air, the cold made the red color turn to yellow, or in other words caused mercuric iodide to exercise a changed influence upon the incident and reflected light; as the cold passed away, the substance returned to its normal color. The cold slightly alters certain organic coloring matters, but not to the same extent, so far as he had tried.

A soap bubble dropped into a tube, at the bottom of which liquid air is evaporating, becomes frozen, and keeps its colors, except that he has never yet succeeded in freezing the black spot of the soap bubble.

An American experimenter had found that the temperature of −80° C. reduced the power of the magnet, but this takes place alone with supersaturated magnets; with a normal charge of magnetism the power is increased. He coiled a wire round a magnet, and then, when he dipped its poles in liquid air, an electric current was generated in the wire. At −180° C. the power of the magnet is increased 50 per cent. Faraday thought it probable that at low temperatures metals might be much more magnetic.

He performed several experiments with ordinary high vacuum tubes, showing that in all cases the chilling of them outside with liquid air prevents, or nearly prevents, the passage of the discharge inside the tubes.

Professor Dewar gave the following figures in relation to some of his experiments on thermal transparency.

*Amount of Heat Transmitted through a Cylindrical Glass Vacuum Vessel containing the following Liquids.*

*Colza Lamp Radiation.*

| | |
|---|---|
| Chloroform | 1·0 |
| Carbon bisulphide | 1·6 |
| Liquid oxygen | 0·9 |
| Liquid nitrous oxide | 0·93 |
| Liquid ethylene | 0·60 |
| Ether | 0·50 |

By favor of Professor Dewar we are in receipt of an advance proof of one of his past lectures on "Liquid Atmospheric Air," and gather therefrom the following particulars not previously published in these pages.

He says that mercury vapor, even below a millionth of an atmosphere pressure, behaves like an ordinary saturated vapor, and that the mercury therein can be brought down as metal by cooling a part of the outside of the bulb to −180° C. by the application of a pad of cotton wool saturated with liquid oxygen; if this mirror, however, be kept cold, another mirror cannot be brought down upon another part of the bulb by the application of the same low temperature. His experiments led him to conclude that in the high vacuum thus produced glass itself gives off some kind of vapor. The perfection of the vacuum in different vessels thus prepared, all treated in the same way, differs very much, and after use they almost invariably deteriorate. This leads us to suggest that experiments with different kinds of good glass are desirable, especially with the sixty or more now made for optical purposes and upon scientific principles at Jena.

As yet he has found none among the many substances examined which will aid in giving such good vacua as does mercury. Sulphur has been tried and not found to be an improvement, chiefly because traces of organic matter are decomposed by the sulphur, giving sulphureted hydrogen and sulphurous acid, which dissolve in the sulphur and remain therein.

Professor Dewar says that an interesting experiment may be made by immersing an electric pile, composed of carbon and sodium, into liquid oxygen, when almost immediately the electric current ceases. The gaseous oxygen coming from the liquid must be exceedingly pure and dry, and as it has been alleged two chemical substances require the presence of a third one in order that they may combine, it was interesting to ascertain if a substance like sulphur would continue to burn after ignition in such an atmosphere. Sulphur placed in a small platinum vessel that had just been heated to redness was raised to the boiling point, and in the act of combustion lowered into a vacuum vessel containing liquid oxygen. The combustion continued active, and for a time could be maintained in the middle of the liquid oxygen. This result suggests that oxygen and sulphur can enter into combination in a perfectly dry condition.

He says that the best test of the quality of any vacuum obtained is in the relative rates of evaporation of liquid oxygen under the same conditions in different vessels. In many of the large vessels used for the storage of liquid gases, it is convenient and more effective to cause the deposition of a mercury mirror over the surface of the inner vessel, by leaving a little liquid mercury in the lower part of the double-shaped flask, instead of silvering, as previously described. Under such conditions the mercury instantly distills and forms a brilliant mirror all over the surface of the inner vessel. The facts that mercury has a very high refractive index and is a bad conductor of heat are factors of importance in retarding the conveyance of heat. After the mercury mirror has been formed, any further increase in the thickness of the film can be prevented, and at the same time the vacuum improved by freezing the excess of liquid mercury in the lower part of the vessel. The vacuum vessels described equally retard the loss as well as the gain of heat, and are admirably adapted for all kinds of calorimetric observations. The future use of these vessels in thermal observations will add greatly to the accuracy and ease of conducting investigations.

## ART AND OPTICS.*

THE guardian who, in the intervals between divine services, guides visitors through the pretty Russian church of Geneva, directs their attention to a painting representing, of natural size, a youth bearing a palm and advancing toward them. There is no question of it, the motion of his feet indicates that he is moving at right angles with the canvas; but, if one moves to the right or to the left, the feet seem to turn, and as obliquely as one may look at the painting, the young man is always advancing toward him. The astonishment at this singular spectacle is carefully kept alive by the guardian, who goes into raptures before this extraordinary display of skill of an artist who has discovered a secret of perspective; and, as the place leads him more to contemplation than to analysis, the spectator remains surprised to see the handsome young man ever directing himself toward him. But, later on, reflection asserts its claims, and one would then be tempted to propose to the painter a much more extraordinary problem still, and that is so to manage that a person shall advance toward the spectator standing before him, and not follow him when he moves to one side.

The case that we speak of is rare, or else little attention is paid to it, but every one knows that a portrait follows everywhere with its eyes the person that is looking at it, and to such a point that a slightly uncomfortable feeling sometimes results from it. We shall revert to this after recalling a few simple facts.

In the first place, do we not, by a skillfully drawn perspective, become deceived as to the relative size of objects? A well known optical illusion is that of a

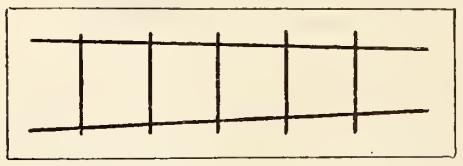


FIG. 1.—THE VERTICAL LINES ARE ALL EQUAL.

long passageway in which several persons are placed. If they are exactly of the same size, they will seem to increase in measure as they stand in more distant planes. The few lines marking the corners of the passageway give us so well the impression of a vanishing, and we so well feel that these converging lines in reality represent parallel ones, that the small images, all equal, are unconsciously measured by a variable unity. There is here not only the elementary illusion due to the approaching of the lines (Fig. 1), but a more complex illusion due to the unconscious interpretation given to the drawing of perspective.

In Fig. 2 we have endeavored to give a contrary illusion. A bridge is decorated with flags, which perspective ought to make appear equal, as well as the arches of the structure, and we judge them such by the interpretation of the drawing, but the feeling of reality to which the latter corresponds has such an influence upon our judgment that we shall never estimate the furthermost arch such as it is seen in the small one figured in the interior of the first. We have therefore made the first point that in a drawing we judge very badly of the relative size of objects. Their surrounding, distant or near by, makes them appear smaller or larger, and in a proportion greater than might be supposed at first sight. But, as we shall see, this principle is not of an indefinite elasticity.

Is a picture the projection of the object that it represents? Sometimes, perhaps, but certainly very rarely. When, for example, a person presents himself under an odd and not very ordinary aspect, the knowledge that

FIG. 3.—PORTRAIT OF MAN IN THE MUSEUM OF THE LOUVRE.

we have of the relation of his lines re-establishes him in our mind in his correct proportions. If he is very near by, our eye, seeing in succession the various parts of his body, applies a different scale to the visual angle, so that everything is brought back to its true size. Such is not always the case in an image, and we shall not dwell upon the unfortunate photographs by inexperienced amateurs in which the feet and hands take up so large a space. In a picture the person is often seen close by, but the artist has not only projected him; he has interpreted him. What would be thought

* See article on this same subject entitled "The Descriptive Arts and the Exact Sciences," in SUPPLEMENT No. 869.

of the Venus of Milo by those who might judge of it through a photograph only? In the hall in which it is placed at the Museum of the Louvre, the photographer is too near and especially is he placed too low. The spectator re-establishes the direction of the lines in his mind, but in the camera they are marked as one has never seen them, or at least as one has never felt them, and it is thus that the photograph gives us a long-necked Venus of a not very pleasing aspect. But, it may be said, it will suffice to look at the image in the direction in which it has been taken, and the true dimensions will be re-established of themselves. That, even, is not exact, for only by the aid of an artifice can we bring the image back upon a plane at right angles with the visual ray. In reality, we perceive it upon an oblique plane, and instead of judging of the image by

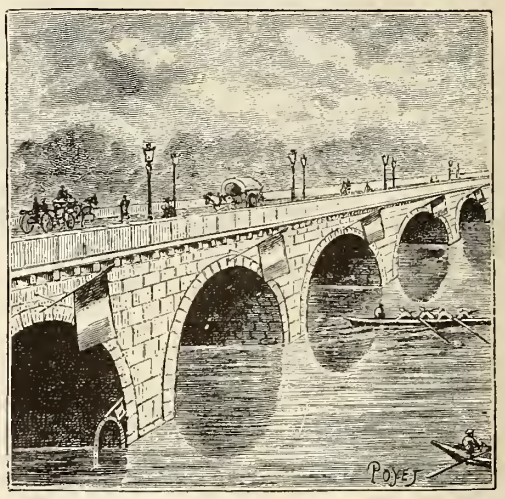


FIG. 2.—PERSPECTIVE OF A BRIDGE WITH THE FARTHERMOST ARCH SHOWN BY DOTTED LINES WITHIN THE FIRST.

the angle at which its various parts are seen, we measure it by the real length of the lines upon the paper, and it always appears distorted. There is an automatic process of giving the aspect of the solid state, but we shall be content to say for the moment that a draughtsman, stationing himself at the same place as the photographer, will give us an image of the goddess that will in nowise shock us, because he will have corrected what the simple projection possesses of faultiness. Let us take another example, geometrically simpler. A picture of large dimensions generally corresponds to quite a large total visual angle, often greater than 30 degrees. Let us consider a sphere placed at the edge of the picture not far from its horizontal median line. Its projection is an ellipse, whose elongation is clearly shown in the conditions that we have supposed, and it will appear such in a photograph; but what painter is there who, in order to remain within the bounds of geometrical accuracy, will represent a sphere by an ellipse? It is not thus that he sees it, for in shifting his glance he carries along the plane of projection, which remains always at right angles with the visual ray; and the spectator, for the reasons given above, finds a circle of more advantage than an ellipse for the representation of a sphere.

We can now return to our starting point, and explain it in beginning with a simple geometrical figure. Let us take Fig. 2 again. On placing ourselves properly in face of the engraving, we see exactly the direction of

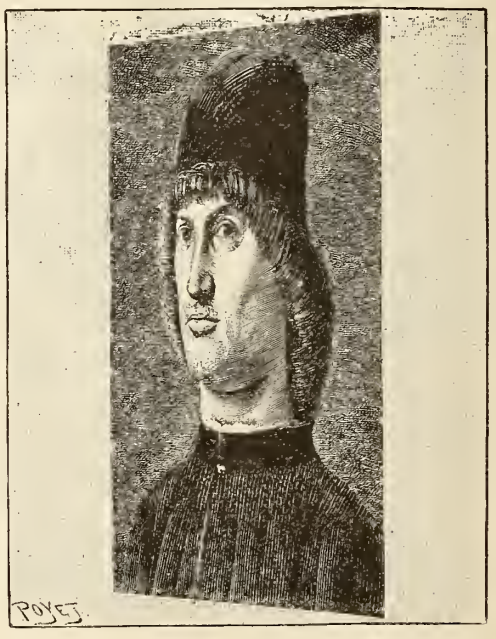


FIG. 4.—THE SAME SEEN AT AN ANGLE OF 60°.

the bridge with respect to the paper, which it intersects nearly at right angles in inflecting itself toward the right while extending to a distance. But let us move from right to left, and the bridge will begin to turn and pass always to our left.

This impression is striking in certain Italian paintings in the Louvre, Notre-Dame de la Salute, for example. If, when we are situated very obliquely, we bring the paper at right angles with our visual axis, the landscape no longer experiences anything but an insignificant displacement, although at this moment we are communicating to it all the rotation that we have just attributed to it. It is here the proportion

occupied by the various portions of the picture on the paper that gives us the idea of the form and direction of the objects, and such proportion remains nearly the same in all our displacements. Moreover, as in every position we have a perception of the direction of the paper, we re-establish in our mind the intention of the draughtsman, and the objects appear to us seriously distorted only under the almost rasant incidence. If we now pass to a portrait, we shall immediately find that the direction of the gaze is manifested to us by the proportion of white that is found above and below the iris and to the right and left of it; and as the eye is strongly convex, such proportion varies rapidly with the position of the spectator. Upon a canvas, such proportion remains constant, and it is for this reason that the gaze seems to follow us. But if, through some not very artistic artifice, we give the canvas a suitable curve at the point of location of the eyes, the latter will appear to be absolutely fixed, and, as the perspective of the face contributes to the effect of rotation, the portrait will seem to turn toward us, while the gaze will preserve a constant direction. Autonello of Messina's admirable portrait of a man (Fig. 3) shows us in a striking manner the oblique gaze that follows us in all our movements, passing always to our right, even when we place ourselves almost in its plane. At 60 degrees from right angles, it scarcely appears distorted, while in reality we see the image represented in Fig. 4—a sort of caricature whence all relief has disappeared.

It is thus that appear to us the portraits hanging on the walls in photographs of interiors. A comparison of Figs. 3 and 4 shows us how great is our tolerance for images seen in an oblique direction.

How difficult it is to represent the eyes by sculpture is well known. A singular fact, ascertained by Mr. Waldeyer, a German scientist, is that in the Greek statues the curve of the eyes is sensibly less than that of our visual organ. Why such singularity with a people who have so faithfully copied nature? It seems evident that the artist rendered the impression without servilely copying the reality. Now, the true visible surface of the eye is that which, starting from the sclerotic, continues through the iris, in which the pupil appears like a projecting point. It is doubtless this surface that the Greeks followed. The color did the rest.

The Egyptians, it is said, incrusted the eyes in quartz. Certain Hindoo idols have eyes of black diamonds, yet in this case we must perhaps see the idea of honoring the essential organ of the god, rather than an artistic intention. We desired to explain the walk of the young man of whom we spoke at the beginning of this article, but we can now dispense with doing so, since all the reasons for it have been given in what precedes. We desire only to insist upon the fact, of which we shall find numerous examples, that the artist in falsifying the principles of optics arrives at the truth much better than he who conforms to them.—*C. E. Guillaume, in La Nature.*

AN improved system of increasing the illuminating power of common house gas by burning the fumes of heated oils in conjunction with it, by C. H. Harrison, London, consists of a metal oil holder, into which ordinary coal gas enters through a tube, and leaves it through other tubes, passing to the burners. It is so placed that the burner heats the oil and drives off from it vapor, which mixes with the gas before burning. The apparatus is fixed to the pipe or gas fitting.

## THE FIELD COLUMBIAN MUSEUM, CHICAGO.

THE fine arts have made way for natural history in the beautiful building at Jackson Park, and it is hoped that by May 1 the doors of the young but thriving museum will be thrown open to the public.

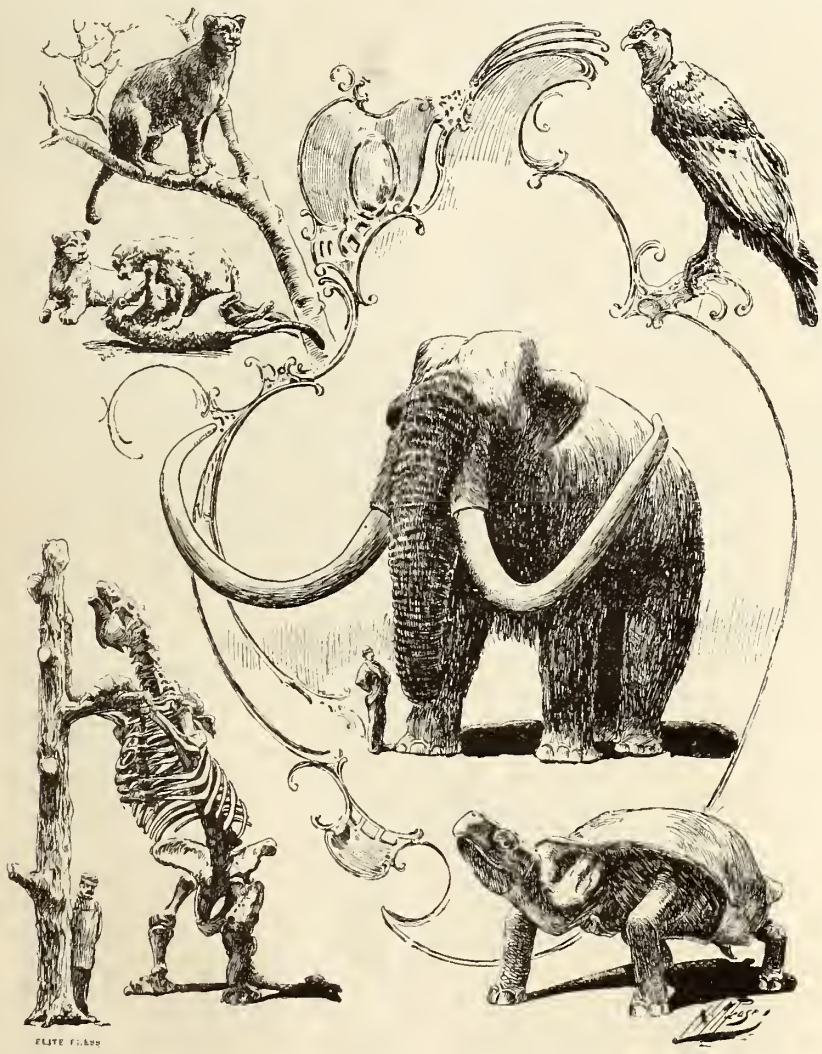
The total floor area available for display purposes aggregates 224,828 square feet. In addition to this there are several hundred thousand square feet of wall space that will be occupieed by cases. These areas are subdivided among the various departments, in each of which installations are being made under the supervision of a competent chief.

Prof. Ward and a staff of experts have arranged the Ward zoological collection purchased by the museum. It is installed in the southwest section of the building and overflows into the west court. Several of the most interesting specimens of this remarkable collection are shown in our illustrations, for which we are indebted to *Elite.*

In the center is the "Mammoth," reconstructed after bones found near Stuttgardt, Wurtemburg. Left upper corner, "Group of Pumas," from Colorado. Right upper corner, "Peruvian Condor," very rare. Left lower corner, "Megatherium Cuvieri," modeled from remains found near Buenos Ayres. Right lower corner, "Colossochelys Atlas," from India.

The museum will probably lose Mr. L. Z. Leiter's contribution of $100,000. The terms of the gift required that the aggregate collection should be known as the Columbian Museum, with permanent location at Jackson Park. The museum has already been named in honor of Mr. Field, and no stipulation has been made as to its final domicile.

The museum trustees are considering the advisability of purchasing the C. B. Corey ornithological collection of Boston. Mr. Corey's fame as an ornithologist is world wide, and his collection the rarest that could be obtained. It is valued at $100,000, and is offered for $17,000, a sum that will little more than pay the expenses of preparing the collection for shipment to Chicago.



MAMMOTH AND OTHER OBJECTS IN THE FIELD COLUMBIAN MUSEUM, CHICAGO.

The report submitted by the insurance underwriters, a few days ago, on the fire-resisting qualities of the Fine Arts building is not particularly flattering; but it is asserted by Mr. Burnham that the structure can be made practically fireproof by putting iron beams under the main floor and laying hollow tile between the floor and the beams. The cost of this improvement is estimated at $100.000. The exterior of the building can be made permanent by terra cotta or cast Portland cement, reproducing all the ornamental details, at an estimated expense of $250.000.

## INTELLIGENCE OF THE CHIMPANZEE.

"THE Royal Natural History." Edited by Richard Lydekker, B.A., F.G.S., etc. (London: F. Warne & Co.) If the two parts of this book which have been already published are fair samples of the thirty-six in which it is to be completed, the complete work will certainly be the handsomest and most readable book on general zoology which has yet appeared. It does high credit to all who have had a hand in its production, being not only full of information conveyed in simple and more comprehensible language than zoologists ordinarily employ, but it is beautifully illustrated with woodcuts and colored pictures that exhibit a high degree of artistic merit controlled by scientific accuracy. In the two parts before us we have the first installment of Mr. Lydekker's treatise on mammals, which is to extend over fifteen monthly issues, and is to be followed by an important section devoted to birds, to which Dr. Bowdler Sharpe, Mr. Ogilvie Grant and Mr. Macpherson are to contribute largely; the remaining twelve parts will continue the survey of the descending series of forms of life to the lowest of the invertebrates. Part I. has a capital introductory chapter on mammalian characteristics, and the attack on the constituent orders is opened with an exhaustive survey of the primates, which are reviewed *seriatim* from the anthropoid apes to the colobine monkeys; the subsequent groups down to the marmosets occupying the second part. Every genus is described in full, over a hundred and thirty representative species coming under notice, most of them at considerable length, with much that is interesting as to their distribution, habits and history; and this information is not of the obsolete, hearsay kind frequently thought good enough for repetition in popular works on zoology, which contain much that the student has subsequently to unlearn. The chief place among the many excellent features of this work must be given to the broad and powerful treatment of the paleontological side of the subject, which, as our readers already know, Mr. Lydekker is specially fitted to deal with. Every species is compared with its nearest allies or direct representatives as revealed in the record of the rocks. The illustrations are very numerous and cannot be too warmly praised.

Mr. Lydekker's description of the larger anthropoid apes will be found extremely interesting. He reminds us that a full grown male gorilla, if standing in a perfectly upright position, will generally measure rather more than six feet in height; and since his body is much more bulky, and his limbs are longer than those of man, he is considerably the largest representative of the primates. Gorillas habitually live in small families, having young ones of various ages with them. They live a wandering life and do not frequent the same sleeping place for more than three or four consecutive nights, traveling considerable distances through the dense forests in search of fresh supplies of suitable food.

Although in appearance male gorillas are somewhat unwieldy creatures, yet they are most active and indefatigable climbers, and are said to ascend to the very tops of the forest trees, where they pass from tree to tree almost as readily as the far lighter spider monkeys of Brazil. They are also capable of taking leaps from great heights to the ground without damage to themselves. Herr von Koppenfels says that he saw an adult spring from a tree at a height of some thirty or forty feet, and on alighting disappear into the scrub.

Of all the large man-like apes, those which on the whole make the nearest approach in bodily structure to man are the chimpanzees of western and central equatorial Africa. In the autumn of 1883 a young chimpanzee, called "Sally," was purchased by the Zoological Society of London. Mr. Bartlett, the superintendent of the society's gardens, soon recognized that she was very different from the true or common chimpanzee, and he considered that the animal was probably one of the black-faced chimpanzees, termed by Du Chaillu "bald chimpanzees." The ordinary chimpanzee has a white or pale flesh-colored face, hands and feet, and is a vegetable feeder, but "Sally" showed a disposition to live upon animal food. Mr. Bartlett says that soon after her arrival he found that she would kill and eat small birds; seizing them by the neck, she would bite off the head and eat the bird—skin, feathers and all. For some months she killed and ate a small pigeon every night, but after a time her keepers supplied her with cooked mutton and beef tea, upon which she did very well. She was an expert rat catcher, and caught and killed many rats that entered her cage during the night.

Mr. Bartlett soon recognized that her intelligence was far above that of the ordinary chimpanzee; she quickly recognized those who had once made her acquaintance, and paid marked attention to men of color by uttering a loud cry—*bun, bun, bun.* Dr. J. G. Romanes made her acquaintance and endeavored to test her mental powers. His account of her was written in 1889, after she had been nearly six years in the Zoological Gardens. He compared the intelligence of "Sally" to that of a child a few months before emerging from the period of infancy, and considered that it was far higher than that of any other mammal, with the exception of man.

In spite, however, of this relatively high degree of intelligence, the creature's power of making vocal replies to her keepers, or those with whom she was brought into contact, were of the most limited kind. Such replies were restricted to three peculiar grunting noises. One of these indicated assent or affirmation; another, of very similar intonation, denoted refusal or distrust; while the third, of totally different intonation, was used to express thanks or recognition of favors. In disposition, says Dr. Romanes, "Sally" was, like many of her sex, apt to be capricious and uncertain, although on the whole she was good humored and fond of her keepers, with whom she was never tired of a kind of bantering play, which was kept up at intervals almost continually. By singing in a peculiar kind of monotone in imitation of her own utterances, her keepers were usually able to induce her to go through a series of remarkable actions, the meanings of which were not very apparent. First she would shoot out her lips into a tubular form, uttering at the same time a weird kind of howling note, interrupted at regular intervals. The pauses would, however, gradually become shorter and shorter, while the sing-song became louder and louder, until it finally culminated in a series of yells and screams, not unfrequently accompanied with a stamping of the feet and a violent shaking of the netting of her cage. After this climax the utterance of a few grunts terminated the performance.

It occurred to Dr. Romanes (from whose account Mr. Lydekker quotes) that "Sally" would be a good subject on which to test the powers of an ape's intelligence. He found, however, that his experiments were seriously hampered by the effects on the creature of the visits of the numbers of people who were constantly passing in and out of the room in which she was kept, and there is consequently little doubt that under more favorable circumstances the results ob-

tained would have been more remarkable than they are. Having secured the assistance of the keepers, Dr. Romanes requested them to ask "Sally" repeatedly for one, two, or three straws, which she was to pick up and hold out from among the litter strewing her cage. The number of straws asked for was constantly varied and never followed any regular order, and when the correct number was presented the animal was rewarded by a piece of fruit, while if the number was incorrect her offer was refused. In this way the ape was easily taught to associate these three numbers with their names. Lastly, if two or three straws were demanded she was taught to hold one or two in her mouth until she had picked up the remaining straw, and then to hand the two or three straws together. This prevented any error arising from her interpretation of vocal tones. As soon as she understood what was required, and had learned to associate these three numbers with their names, she never failed to give the number of straws asked for. Her education was then extended in a similar manner from three to four, and from four to five straws. Here Dr. Romanes allowed her education to terminate. But one of her keepers endeavored to advance her instruction as far as ten. Although she very rarely made a mistake in handing out one, two, three, four or five straws, and was usually accurate in handing out as many as six or seven, when the numbers eight, nine or ten were named the result became more and more uncertain, so as to be suggestive of guesswork.

It was evident, however, that she understood the words seven, eight, nine and ten to betoken numbers higher than those below them; and if she was asked for any of these numbers, she gave some number that was above six and not more than ten. On the whole, therefore, while there was no doubt that "Sally" could accurately count up to five, beyond five her accuracy of computation became progressively diminished. Owing to the method of picking out the straws above described, the operation was a slow one and imposed a considerable tax upon her patience; and as her movements were deliberate and her store of patience small, Dr. Romanes thought that the uncertainty which attended her dealing with the numbers six and seven was more frequently due to her losing patience than to her losing count, although after seven he believed that her computation of the numbers became vague.

We heartily concur with the popular Secretary of the Zoological Society in commending "The Royal Natural History," not only to every naturalist, but to every lover of nature.—*Knowledge.*

## THE TYRRELL EXPLORATION OF THE TERRITORY WEST OF HUDSON'S BAY.

The *Express* has at various times had occasion to chronicle the discoveries of explorers in the Canadian Northland, and this week is enabled to give an account of the Messrs. Tyrrell, who of all the exploratory staff, are most the talk of the Dominion at the present. Hitherto the work of discovery has been paid for out of funds provided for that purpose by the British government, and it was left to the Tyrrell brothers to inaugurate the purely Canadian expedition and to bring it to a most satisfactory close. The chief of the party was Mr. Joseph B. Tyrrell, geologist, and a Toronto University graduate. His brother, Mr. James W. Tyrrell, surveyor, acted as geographer.

Although still a young man, Joseph Tyrrell has seen eleven years of this sort of service, having covered the country from Lake Winnipeg to the Columbia River, across the Rockies, and from the boundary line as far north as the top of Hudson's Bay; while his brother is known to be no novice, from his having acted as surveyor for Lieutenant Gordon on his recent Hudson's Bay expedition,

When geologist Tyrrell landed in Toronto the other day he was attired in Arctic summer weather habiliments of gaudy scarfs, leggins, moccasins and blanket ulster that made the populace shiver as he navigated toward the up-town residence of his brother, Dr. Tyrrell. He looked the picture of health, and was brown as a nut. All the way up to Dover Court road at intervals he found himself breaking into an Indian lope, such was the force of the snow-shoe habit. His story as related to the *Express* representative will be found of uncommon interest.

"In 1892, when I was exploring on Lake Athabasca. I sought to obtain from the Indians some idea of the country to the northward, and they told me of two or three routes that they took to their hunting grounds, skirting the Barren Lands. They knew on the other side of the divide rivers had sources, but had no idea where they flowed to. The Barren Lands had long been a district of mystery to the government, known only to Indians themselves in a sort of legendary way, and the department at Ottawa to whom I reported resolved to explore the country between the Athabasca and Mackenzie River basins and Hudson's Bay, and to determine whether or not the vast area of 200,000 acres could claim richness in fur-bearing animals or minerals I was put in charge, and when on May 26 we assembled at Edmonton, our party consisted of myself and brother, three Prince Albert Indians and three Caughnawaga Iroquois. I did not trust to the Athabasca Indians for help, because I had found in the preceding summer a general belief that any one entering the Barren Lands was sure of being devoured by Esquimaux. The Indians from Montreal were taken because of their adroitness in canoe work, and I don't think a better steersman exists in the world to-day than Peter French, who handled my canoe. It was he who got himself into the papers a few years ago for running the Lachine Rapids on Christmas Day, out of sheer bravado.

"From Edmonton in wagons we drove our two Peterboro canoes, each with carrying capacity of 1,800 pounds, to Athabasca Landing. At Fort Chippewayan or Chipwyn we gathered supplies, in weight about 2,000 pounds, and possessing ourselves of a third canoe used in a former expedition, we set forth eastward, making as we went a survey of the north shore of Lake Athabasca. The last place that Indians were encountered was at Fort Fond du Lac, half way along the shore.

"This was formerly an important Hudson's Bay post, built to gather reindeer meat for their Mackenzie River forts, but now abandoned save for the presence of a few Indians in the vicinity. In a box consigned to Fort Chipwyn left in June with some of the latter was a letter, that the Ontario papers published in October, making mention of a native guide secured to take us up to the Barren Grounds. That guide deserted the very day after I wrote that letter.

"You see, bordering on the Barren Lands, is a wooded belt of about 100 miles; this is the farthest the natives ever penetrate, and the Indian thought by leaving us in the lurch we would be deferred from our purpose. He did not want us to know the way into their hunting grounds, and said, although perhaps we didn't want to hunt ourselves, we would show other white men the way, and take the food out of the natives' mouths.

"I meet this difficulty every year," said Mr. Tyrrell, "but can't blame the poor Indians at all. In a way, what he said is perfectly true. Well, from the end of Lake Athabasca, without guide or maps, we struck northeasterly on one of the routes I had heard of in 1892, ascending Black River into Black Lake and arriving at the southerly edge of the Indian hunting ground by the beginning of July. Still in the same direction our course lay up a small river, where portages were frequently resorted to to overcome rapids and falls, until we gained a large lake. Pushing on from its northern extremity we traversed a mile or so of swale to come upon another lake of considerable size which lies about the center of the hunting grounds. The outlet to this was, after tedious search, discovered on the north side; being, in fact, the mysterious river spoken of by the Athabasca Indians. We began the descent, knowing not whether it had outlet in the Arctic Ocean or Hudson's Bay, although we fondly hoped the latter. This river throughout its length we found to be lacustrine, and much time was lost by this, as it was ever difficult to pick out the particular arm of each successive lake that gave egress to the river. Between these widenings out invariably occurred rapids, both lengthy and rapid, but the dexterity of our Caughnawaga steersmen brought us safely through all but an occasional stiff one that necessitated a portage. In August we came to a lake, which must be the Lake Dubaunt or Doobaunt so variously located on the maps. Although in midsummer, ice seven feet thick covered it, except close to shore, where, in a narrow channel, for

ROUTE OF THE TYRRELLS TO CHESTERFIELD INLET AND RETURN.

100 miles we paddled our way around in full view of the hillsides that were still covered with snow.

"From this time we were on the lookout for Chesterfield Inlet, as our observations for latitude and longitude helped us to a good idea of whither the river was bearing us, and about September 1 we reached the inlet's western extremity. We had with us some rough plans dating from the time when, in the middle of last century, expeditions were searching for a northwest passage to China, and now we made use of them, correcting by survey their many inaccuracies. In size this long river can best be compared among American rivers to the Ohio. On the 10th we drew up our canoes on the inhospitable shores of Hudson's Bay; certainly the first white men to cross the 850 miles intervening between the great inland sea and the Mackenzie and Athabasca basins, and as no record exists of an Indian having done it, most likely our voyage was through country never before traversed by man."

The explorer was asked concerning the physical aspect of this hitherto unknown territory. Said Mr. Tyrrell: "I may liken it to the prairie in a measure. It is a rugged, rolling tract of land, speckled over with swamps, and occasionally, rocky hills. In the whole Barren Lands there isn't wood enough to make a boot peg of, so that, though we were often wet, the luxury of a fire was impossible, and such game as we shot had to be devoured raw. My brother is taking down to Prof. Macoun at Ottawa a collection of flora, the more valuable as it is the first from the Barren Lands. We would often come to a stretch strongly reminiscent of the Northwest prairies from its thick covering of low growing flowers; and as a rule the ground is grassy. The lakes abound with fish, mostly trout and white fish; but here, except for the reindeer, appearances of animal life stop short.

"No birds; no wild fowl, save one or two solitary white partridges—brown at that season; no musk ox, although their presence might be expected; a few scattered white wolves, that is all, if you except the reindeer. And the big antlered fellows roam supreme in the Barren Lands. Once we saw a herd that fairly hid the earth for a whole three miles; and at the smallest possible calculation there could not have been less than several hundred thousand, feeding there on the damp grass. Only for the deer the party's larder would have failed entirely, as the dried meat constituted the principal diet.

"When we reached Hudson's Bay we had left only ten days' provisions after crossing this 'great lone wilderness,' but stayed round the mouth of the inlet for two weeks completing the surveys and observations. We left in the middle of September, just as the ice was beginning to form, and started by canoe on the 500 mile voyage southward to Fort Churchill, surveying the coast as we went. We soon discovered we had fared remarkably well on our overland trip in comparison with this progress in frail canoes on the high seas. Equinoctial gales and head winds prolonged our trip to one of 40 days' length. At first continual cold, driving rains brought us misery, and until the frost grew intense we had to sleep every night in our suits of reindeer fur and rabbit skin blankets, both wet. Although we landed at night time for a camp, it brought no relief, for within 400 miles there was not one stick of wood, and over everything lay eighteen inches of snow. Our provisions had long since given out and there were days when we lacked one bite to eat; on several others we managed to shoot two or three ptarmigan, or a like number of ground squirrels, but divided among eight, to be devoured raw, that could not be called fare any too ample. Sometimes our guns brought down a sea duck, when we got well off the coast, as in crossing deep bays, but they were poor substitutes for the shore duck that had all flown south. One lucky cartridge brought a polar bear into our clutches; he was devoured to the bones and skin.

"At one time we were two days on the sea at a time. To tell how it happened, I must explain that the tides were a source of perpetual annoyance and danger, rising from fourteen to eighteen feet. When the tide is out it leaves along the bleak and slightly elevated shore a belt of from four to five miles of shallows, dotted close with massive bowlders. To land in safety you thus have to pick your time when the tide is at the highest point; and on the occasion mentioned it was midnight, and snowing into the bargain. At another time we were unable to put to sea for five days.

"By October 16, we were still thirty miles from Churchill Factory's pretentious array of seven or eight houses, but the ice was forming so fast that progress by canoe was impossible. Every one in the party was very weak from hunger and exposure, but I sent the two strongest Indians on foot south for dog teams. They succeeded in hiring four, and also brought back much needed supplies, so that at length we got our canoes to Churchill in safety, the people being greatly surprised at seeing white men come from higher latitudes than even they inhabit. Here, because the river was not frozen, we had to delay two weeks, although part of this time we were glad of it. My strength gave way a short distance from the factory, I having to be carried in, and the condition of the rest was almost as deplorable from the trials of that trip down the bay. The legs and arms of every one in the party, shortly after getting there, swelled to over twice the natural size; but the kind attention received soon put us right again.

"With one dog team we started for York Factory on November 6, reaching the Nelson River in a week, but as it was full of floating ice, and we could neither ferry it nor cross on foot, another delay of ten days had to be submitted to, although we were just able to exist on the small game we could shoot. Finally, we crossed in a boat and were warmly welcomed by Dr. Milne, the chief officer at Fort York. On December 7, we reached Oxford House, 250 miles further in a southeasterly direction, having employed ten days in the walk on snow shoes alongside the dog team, and, after waiting there a few days for another dog team, we set out for Norway House, and arrived on December 20. Here with no trouble we secured four dog teams and made the 350 mile trip to Selkirk in the short space of ten days. This long snow shoe tramp from Churchill to Norway House made a total of about 600 miles, which is in itself quite a feat, considering that all the time the thermometer lingered about 40 below zero mark. We passed the nights under the open sky, going to sleep beside a fire that generally died before midnight; and our covering consisted of Esquimaux clothing and blankets made of rabbit skin. Yet we felt the cold very little and certainly it was an improvement on the coasting voyage, for I myself had already gained forty pounds in weight since leaving Churchill. Concerning the latter I may say that our survey will completely change the shape of the Hudson's Bay shore, as we are the first ever to come down the coast in canoes, and existing maps rely only on the few observations of sailing vessels that have taken a 'sight,' here and there, when lying-to from ten to twenty miles away.

"As regards the main objects of the expedition it was entirely successful; we have proved that, but for what minerals may be found among the very varied rocks of the Barren Lands, it is of small value."

Thus ends the history of the longest trip through entirely unknown portions of the continent undertaken since Sir John Franklin was engaged in his ill-starred Arctic expeditions. The total mileage by canoe was 2,200, of which 850 was through new country; the total by snow shoe travel was 650, and by dog sled 350.—*Buffalo Express.*

Impervious Sack or Sacking.—The sacking consists of a woven fabric or ordinary sacking of either flax, jute, or hemp. It is coated on one side with a compound adapted to render it impervious to damp or atmospheric influence. This compound consists of a mixture of artificial bitumen (refuse from petroleum distillation), 60 to 80 parts, pitch, such as is obtained as refuse in the saponification of palm oil, 5 to 20 parts, and chalk about 20 parts. After application of this mixture, a layer of thin paper is pressed down upon it, so as to act as a protection against adhesion of other matters. This sacking may be prepared in the piece and then cut up to form sacks or bags. A machine for the application of the compound to the sacking forms part of the claim.—*E. Pierret, Vilvorde, Belgium.*

# THE PHYSIOLOGICAL AND PATHOLOGICAL INFLUENCE OF VEGETABLES UPON MAN.

By MARK I. KNAPP, Member of the Senior Class of the University Medical College, New York.

MAN is made up of a multitude of elements and compounds, each of them having its exact destination and each being necessary to his constitution. Each and every one of those chemicals which make up our tissues are constantly undergoing changes, are eliminated, and must consequently be supplied with new material. Must we not, therefore, be on our constant lookout to supply as well our used-up nerve tissue as the muscular and glandular structures, fat, bone, etc. ? Remembering the diversity and multiplicity of the components of the many tissues that make up our system, can we then confine ourselves to only one certain diet ? Can we feed a man with only certain articles, excluding others, without a necessary reaction or disturbance taking place ? Or, have all our articles of nutrition the same chemical composition which would make a selection immaterial ? No, the same chemical constituents that meats have, vegetables have not ; and even if they have like quality, they do not have like quantity. The albuminous matters are in different proportions in meats and in vegetables. The proportions differ in different kinds of meat and in different kinds of vegetables ; and if we have enough of nitrogenous substances in a pound of meat to supply the waste of one structure, we lack the proper amount of earthy salts to satisfy other tissues. We can, therefore, neither confine ourselves to the exclusive use of meats nor to that of vegetables ; they are of like importance to sustain our equilibrium of health and life.

A few analyses, taken from "Chemie der menschlichen Nahrungs und Genussmittel," by Prof. Dr. J. Konig, of Berlin, will conduce to a better understanding.

From these analyses we see that meats, peas, beans, and some fruits are rich in albuminous substances ; whereas vegetables consist of a relatively very large amount of salts, hay being very rich in calcium salts. Whereas in taking 100 gm. of albuminous matter out of the ox's meat, we would only have 5·61 gm. of salts, we should have to ingest 65·07 gm. of salts to cover the same amount of nitrogenized substance when we take cabbage, or 29·01 gm. if oats be selected as the exclusive food, or 50·256 gm. of salts if potatoes should be the nourishment. It is therefore evident that, in order to supply the necessary quantity of albuminous matter out of vegetables, we must ingest a large amount of salts. Again to cover our lack of salts in an animal diet, we would need to take an enormous volume of it—which would be impossible for us to do. Hence by confining ourselves to an exclusively animal diet, the tissues that depend for their existence chiefly on salts will suffer ; and if preference be given to vegetables, other structures will give symptoms of insufficiency in supply. It is also to be noted that sodium is prevalent in the composition of animal tissue, potassium in that of vegetables : consequently with a larger supply of animal diet, we also introduce more sodium into our system. The necessity, therefore, suggests itself to know at each period of our life the nature, quality, and quantity of the chemical elements or compounds needed by our economy, since our system is always changing, and consequently also our diet will have to vary accordingly. That menu prescribed for the developing infant or child will not hold good for the adult, and *vice versa*. At the same time, finding one article to be predominantly used at a certain period of our life, we should not drive it to an excess ; for any excess of one means and causes an insufficiency of the other, and consequently doing away with the necessary equilibrium, it causes insecurity, danger, *i. e.*, it hurts.

| | Water. | Nitrogen, substance. | Fat. | Extracts. | Salts. | Sugar. | Dextrin. | Starch. | Woodfiber. | Ashes. |
|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % |
| Ox meat, very fat | 72·25 | 20·91 | 5·19 | 0·48 | 1·17 | .... | .... | .... | .... | .... |
| Cow meat, fat | 70·96 | 19·86 | 7·70 | 0·41 | 1 07 | .... | .... | .... | .... | .... |
| Cow meat, lean | 76 35 | 20·54 | 1·78 | ..... | 1·32 | .... | .... | .... | .... | .... |
| Veal, fat | 72·31 | 18 88 | 7·41 | 0 07 | 1·33 | .... | .... | .... | .... | .... |
| Veal, lean | 78·82 | 19·86 | 0 82 | ..... | 0·50 | .... | .... | .... | .... | |
| Mutton, fat | 47·91 | 14·80 | 36 39 | .... | 8·85 | .... | .... | .... | .... | .... |
| Mutton, half fat | 75·99 | 17·11 | 5 77 | ..... | 1·33 | .... | .... | .... | .... | .... |
| Pork, fat | 47·40 | 14·54 | 37·34 | ..... | 0·72 | .... | .... | .... | .... | .... |
| Pork, lean | 72·57 | 19·91 | 6·81 | .. | 1·10 | .... | .. | .... | .... | .... |
| Beans | 13 74 | 23·21 | 2·14 | 53·67 | .... | .... | .... | .... | 3·69 | 3·55 |
| Peas | 14·99 | 22 85 | 1·79 | 52·36 | .... | .... | .... | .... | 5·43 | 2 58 |
| Wheat | 13·56 | 12·35 | 1·75 | ..... | .... | 1 44 | 2·38 | 64 08 | 2·53 | 1 81 |
| Barley | 13 77 | 11·14 | 2·16 | .... | .... | 1·56 | 1 70 | 61·67 | 5·31 | 2·69 |
| Oats | 12·37 | 10·41 | 5·23 | .. | .. | 1·91 | 1·79 | 54 08 | 11·19 | 3·02 |
| Potato | 75 48 | 1·95 | 0·15 | .... | ... | .... | .... | 20·69 | 0·76 | 0·98 |
| Turnips | 89·42 | 1·35 | 0·18 | 3 14 | ... | 4 22 | .... | ..... | 0·66 | 0 75 |
| Melon | 89 87 | 0 96 | 0·28 | 6·57 | .. | 0·57 | .... | ..... | 1 05 | 0 70 |
| Asparagus | 93 75 | 1·79 | 0·25 | 2·26 | ... | 0 35 | .... | .... | 1·04 | 0·54 |
| Cabbage | 89 97 | 1 89 | 0 20 | 2·58 | .... | 2·29 | .... | .... | 1·84 | 1·23 |
| Spinage | 88·47 | 3·49 | 0·58 | 4 34 | .... | 0·10 | .. | ..... | 0·93 | 2·09 |
| Parsley | 85·05 | 3 66 | 0·72 | 6·69 | .... | 0 75 | .... | .... | 1·45 | 1·68 |
| Dandelion | 85·54 | 2·81 | 0 69 | 7·45 | .. | .... | .... | .... | 1·52 | 1·90 |
| Nettle | 82 44 | 5·55 | 0·67 | 7 13 | .. | .. | .... | .... | 1·96 | 2·30 |
| Wormseed | 80 80 | 3 94 | 0·76 | 8 93 | .... | .... | .... | .. | 3 82 | 3·02 |
| Walnut | 4 68 | 16·37 | 62 86 | 7 89 | .... | .... | .... | .... | 6·17 | 2·03 |
| Hazelnut | 3 77 | 15·62 | 66·47 | 9·03 | .... | .... | .... | .... | 3 28 | 1 83 |
| Cocoanut (fresh) | 5 32 | 5·49 | 66 16 | 8 06 | .... | .... | .... | .... | 2 91 | 1 55 |
| Iceland moss | 15·96 | 2·19 | 1 41 | 76·12* | .. | .... | .... | .... | 2 91 | 1 41 |
| Banana | 73 10 | 1 87 | 0·63 | 23·05 | .... | .. | .... | ..... | 0 29 | 1·06 |

* Of which 55·65 per cent. is starch.

As a rule, we understand by the expression "nutritious food" albuminous matter ; whereas it should convey to our mind the idea of such substances as are necessary to all the different tissues of our body, and certainly albumen is not the only thing that is indispensable. That nitrogenized substances are not the ideal predominable nutritious food for the infant and early childhood, that we must not overcrowd the young growing child with albuminous matter, will readily be seen from subsequent remarks.

The framework of anything is the basis of everything, and upon a sound and solid foundation the future existence, solidity, and durability of the whole building depends. However beautifully, artistically executed, the building is always in danger of breaking down if the foundation be not properly secured. It shall therefore be our duty and our first thought to secure, fortify, and strengthen also our framework. What else is our framework but our skeleton, our bones ? To strengthen, insure durability, to cause developing, growing of bone in the young children, we naturally must introduce into the system bone-forming elements, substances of which bone can be formed ; and since bone consists chiefly of earthy salts, since the earthy phosphates constitute two-thirds of the constituents of bone, it will be necessary to introduce into the young, growing system such substances that are rich in salts, which substances belong not to the animal but vegetable kingdom. The same view is also expressed by Konig, who says : "For the growing organism earthy phosphates are of great importance, for out of these the bony skeleton is built up." This innermost, unconsciously felt desire for earthy salts and vegetables we often have occasion to observe in small children. Not unfrequently do we wonder at the perverted appetite of those little ones whom we find at times eating chalk, shells of eggs, etc. They feel and know what they want. Many children can hardly be induced to taste meat, whereas to vegetables they take readily.

The physical development of man depends upon his height and circumference, the causative factor of the first being the relative skeletal development. Of two men, short and tall, both of whom being proportionately built, the taller has a stronger and a more durable constitution ; we must consequently, in order to insure strength, insure height, and to do this we must cause growing of bone by the proper vegetable diet. But since bone, like other tissues, is also always undergoing change, *i. e.*, eliminates used-up matter and takes up new, the necessity of not losing sight of the importance of vegetables throughout life is apparent. We also find that the ancient Roman and Greek athletes ate no meat. From all said until now, we should infer that the height of man and all animals depends upon the growing of their bones ; this latter upon the proper nutrition—an assertion also expressed by Paolo Riccardi. *Only the sufficient or insufficient supply of vegetables determines the respective height of all animals and man ; an abundance of vegetables which contain the earthy salts brings forth tall, an abundance of albuminous animal diet—insufficiency of the bone-forming salts—is the cause of the non-development of skeleton of the short people.*

Heredity and climate have been thought as probable causes of development of stature by some, who necessarily had to find an external cause for simple phenomena. Neither climate nor heredity directly influence the height of man or of animal. Nor is it the altitude. For we find tall and short men in the same village, in the same city, in the same country ; we see tall people of very short parents, and *vice versa*. We meet with tall and short people in the mountainous regions, as well as in the deep valleys ; tall and small men are encountered along the sea coast, as well as in the very heart of the continent. Could it be then anything else but the difference in diet that influences the growth of man and animal ? Could it be anything else but the difference in the material supplied, that causes difference in appearance, quality, and durability of the machine or building produced by such material ? Is it not self-evident that food, and food only—that which is absolutely necessary to give to the living, life—also determines life ? That with a suited nutrition growth is produced, and with a diet wanting the necessary ingredients neither growth nor long life can be sustained. Should we not look for physical and chemical causes only to explain our chemical and physical phenomena of life, instead of looking and seeking for as many causes for as many phenomena ?

Of the fact that only a vegetable diet produces height of animals and man, there is sufficient proof. We only compare the two great classes of animals, the "herbivora" and "carnivora," and the most striking difference, not only in height, but also in other respects, is at once seen. The herbivora, the older animals of our planet, are proportionately built, the carnivora not. The height of the herbivora corresponds to the length of their body ; in the carnivora the body is longer. The head of the herbivora is much larger than that of the carnivora. Herbivora are known to reach an age of up to two hundred years (elephant). Carnivora die very much earlier. Compare side by side the giraffe, elephant, camel, ox, horse, sheep, goat, with the lion, tiger, bear, fox, cat, and see the height attained by the first exclusively vegetarians ; see how proportionately they are built, their height equaling the length of their body, whereby the best of all proportions, that of a square, is given to them, and observe the shortness of legs in the carnivora. In all of these latter, the body length is greater than their height. The mastodon and other prehistoric, very large aniuals, were herbivorous, as seen by the formation of their teeth. Here, certainly, nothing else but the difference in nutrition can make that diversity in appearance and character of those animals, those children of nature upon whom civilization and progress of science cannot pour its enlightening rays. Climate and altitude have no influence here either. For both herbivora and carnivora live in the same woods, on the same mountains, in the same valleys, and necessarily the carnivorous must live where the herbivorous exist. Heredity could be brought up here probably better than in man, but of whom did the first carnivorous animal inherit his shortness ?

Not only, however, does the animal kingdom give us more than sufficient proof of the fallacy of any other theory than diet as the cause of height, also the ethnography of man, who has not yet been brought into intimate connection with the civilized world, proves it with certainty and positiveness.

Even at the present time, almost debarred from any industrial and commercial intercourse, many human tribes exist who are restricted to the products of their own land only, who have to live upon what only their own country grows, many human races who know nothing of agriculture, either of their own fault or that of their climate. The blessing of the rapid railroad train, that medium which serves as an equalizer and rapid distributer of the goods and products of one country to others, that medium which makes failure of crops of one region unfelt by the immediate introduction of superabundance from elsewhere, are as yet unknown to many peoples. Many of these yet live in a primitive state, varying in their daily habits only very slightly or not at all, and consequently can be studied and inferences from them can be much more readily and easily drawn than from civilized people, whose habits regarding diet are much more complex. Such primitive races are found in the north as well as in the south, and like these extremes of climate also, those tribes are extremes in regard to their nourishment and consequent height. The one occupying the north, the Esquimaux, Samoyedes, and the Lapps, are the races known as the shortest ; the tallest known are the Patagonians and Polynesians, who inhabit the south. What a difference of diet in those extremes !

Fr. Muller (Reise der osterreichischen Fregatte Novara um die Erde, Ethnographie, Wien, 1879) gives us the following account : The nourishment of the Polynesian was always predominantly of a vegetable nature. Roots of ferns, berries, cabbage shoots, bread fruit, cocoanut, manioc, and sweet potatoes formed the chief nourishment ; animal products were taken seldom, as a rule only at festivities.

From Friedrich Ratzel's Volkerkunde I took the following extracts : The Hyperboraci do not belong to the tall-grown. A Samoyede—a tribe of Northern Siberia—of 150 cm. height, Middendorf regards as tall among the dwarfs. The shortness of legs of all these races is striking, to which shortness of legs in the case of the Lapps also shortness of arms corresponds. The best foods preferred by them are : Reindeer flesh, dried blood, the contents of the stomach of the reindeer, eggs, some roots, and mossberries. In another chapter, treating of the same short people, he says : "Fishing is the chief source of nourishment besides hunting and reindeer breeding. The nourishment of the nomads of North Asia is pre-eminently of an animal nature. The Obongos, a family of African dwarfs, are experienced hunters ; their nutrition consists predominantly of animal matter."

Rev. S. W. Kolle relates, in his "Polyglotta Africana," that a man of Pati, the residence of Bayon (landinwards of Cameroon), told him there lived at the sea Liba a tribe only three to four feet high ; Kenkob was their name, strong people, excellent marksmen, peaceable, and very liberal men, who lived from the results of their hunting.

According to Emin Bey, who in the year 1882 came in contact with the Akkas, a family of dwarfs in Central Africa, his measurement of a twenty-four year old man gave a height of 124 cm., and that of a thirty-five year old man 136 cm., height ; they are a good and genuine hunting tribe.

Do not these extracts from very competent authorities give us the true and the most satisfactory evidence that to the nutrition, that to the diet only, the height of man is to be ascribed ? that the tall man is indebted for his body length to the abundance of vegetables he takes, and that the exclusive animal diet, the insufficiency of the earthy salts, keeps back the development of the skeleton, keeps back, restricts, the growth of bone, and thus is the cause of the short man ? Does it need any better or more convincing facts ?

I myself have not yet failed in correctly telling a person his likings, whether he rather ate vegetables or meat, which I inferred from his stature ; the above theory proved to be correct, proved to be a fact in every instance without exception. The short man is fond of meat, without which he says he could not live ; indifferent to it is the tall man. "I must have soup and vegetables every time ;" about meats I don't care very much," the latter says. "If I should always have my own choice," one tall man told me, "I would always take vegetables."

Of two children, both girls, the one living in our house, the other the child of a friend of our family ; the first being about three, the second about five years of age ; the first child is strong, robust, fat, and large for her age, the second is small and thin, and everyone remarks "she never grows." As to their diet, the first one, says the mother, eats much potatoes, bread, soup, and vegetables, little meat ; the latter gets no vegetables at all, or only very seldom, although she takes them, if given to her, with great avidity, and must be forced invariably every time to take meat, which the child gets every day, sometimes several times during the day. Another fact—Mrs. F—, thirty-five years of age, rather above woman's average height, not exactly tall, corpulent and strong, when asked whether she liked and ate much meat she replied in a certain tone of pride and self-reliance, "I don't relish meat at all, I must have potatoes at every meal and enough of them ; very often I leave the meat untouched. I never did care for meat." Also other vegetables and cereals form factors of her meals. Her husband is tall and shares the same views with his wife regarding diet. What wonder if her children (boys) are also tall ? Is it heredity ? Have her children inherited the tall stature of their parents ? No ; decidedly not. "A bove majori discat arare minor." As infants and in early childhood they were simply brought up to the same conditions as favored by their parents, as their parents, judging from their own likings, thought wise and correct ; they were subjected also here, as in many other cases of supposed heredity, to the influence of the same causes that typified their parents ; also they have received largely a vegetable diet, considered by their parents as the proper one, they were not asked but given, and of course, as to be expected, the same conditions obtained.

The rejection of meat, so common in pregnant women, and coming on about the beginning of the third month, *i. e.*, commencement of ossification in the fœtus, and at the same time "the capricious appetite, which assumes the form of longing for strange and even disgusting articles of diet" (Playfair), are again proofs for the insufficiency of vegetables, of the bone-forming salts, in the then present condition of the woman's system.

Not only is height dependent upon a vegetable diet, also longevity and mental development are largely influenced by it. This we may infer from the fact that people in bygone years and centuries, at a time when meat was consumed much less generally and in much less quantities than it is now, not only were larger but also lived longer. It is self-evident that a structure constantly being kept in repair, a building whose main walls of support are constantly looked after, and any damage, slight as it be, immediately remedied, will naturally last longer. Again, it is also known that the first to suffer, in another building left to itself, are those parts upon which the safety of the house rests,

and not the facades or any other ornamental work. Just the same is it in man. Bone is the first to show signs of weakness when all other organs still do their work satisfactorily. This, however, is conjecture, and even if vegetables are not the only causative factor of longevity, a factor they certainly are.

Regarding their effect upon the mental faculties, vegetables seem to be of a negative nature. Here again the herbivora and carnivora give us satisfactory proof; higher mental development we find in the carnivora.

To account for the necessity of vegetables to height is easy enough, but I could not yet find any reason why meat should have that effect upon the brain that it does have unless that it is reasonable to judge *a priori* "food of a higher organic development must also bring forth higher mental development." Or the more readily coal, wood, or any other material burns, the larger and brighter is the fire. The more readily the food brought into the stomach is burned up, digested, the brighter is also the fire here, and since meat is more readily and completely digested and assimilated, the greater probably is its stimulating effect upon the nervous system. (The fluid in the cerebral ventricles consists almost exclusively of sodium chloride. Is it the greater quantity of the sodium that is taken in with the animal diet that stimulates the brain? Sodium predominating in animal, potassium in vegetable tissue.) .In the case of the two children related above, the small one—fed mostly on meat—evinces remarkably high mental faculties for her age, whereas the other, the large, with a vegetable diet, shows nothing of sharpness of mind; in fact, rather the reverse is true. We had delight in talking to the first—smaller child—as soon as she could express herself distinctly.

So much for what we may call the physiological effects of vegetables. Now let us consider their pathological influence, if used in insufficient quantity or ill proportion.

The deleterious effects of abstinence from vegetables for a length of time has been recognized already in scurvy. But also in rachitis. lack of earthy salts, *i. e.*, insufficiency of vegetables, is doubtless the cause. Such was my opinion, such was my conclusion about a year ago, when after some time of observation I noted the fact of the influence of vegetables upon growth, and only a few weeks ago when looking around for some book which treated of the chemical analyses of food stuffs and found Koenig to answer my purposes, I read in the same book the confirmation of my views by several authorities; also according to these, insufficiency of vegetables causes rachitis, not the lactic acid. Following are the extracts taken:

Experiments by F. Roloff* prove that in young growing animals with insufficiency of lime and phosphoric acid, diseases of the bones always manifest themselves, and that, the stronger and sooner the greater is their insufficiency. Also the many experiments by E. Voit and Fr. Tuczek† gave the same results. The researches of Hofmeister and Siedamgrotsky‡ prove that the addition of more or less lactic acid, given together with enough of calcium phosphate (hay) produced no such symptoms as are characteristic of osteo-malacia or rachitis, a disease due to lime insufficiency." Rachitis is a disease of the children of the poor, who in the larger cities cannot afford to buy vegetables, which are there much more expensive than meat. These poor children are fed largely on beans, peas, meat and potatoes: the relation between albumen and salts in the first three being nearly the same, and of the latter, the starch being the principal part, they cannot digest enough to give them the necessary quantity of salts. Osteo-malacia is also common in "women who have borne many children," *i. e.*, women who had to give off bone elements from their own constitution to supply the demand of the developing fœtus.

Gout is another disease acknowledged to be due to a high nitrogenous living among others, also to excess of meat.

Laboring under the impression that excess of one means diminution, insufficiency, of the other, that therefore excess of meats means insufficiency of vegetables, I had the opportunity to experiment on a gentleman, Mr. N——, whose urine I examine every month. This is the history: The first analysis I made on May 2, 1892, when I looked for albumen, sugar, excess of phosphates, and although the color of the urine did not indicate any bile or blood, yet I did it for the sake of thoroughness. Regarding these I found nothing abnormal. On July 19 followed the second analysis, when I looked for the same and found the same as on May 2. The third analysis, on August 16, resulted similarly. On September 20, however, I recognized hyperacidity, which led me to look for excess of urates, which I found. Being asked by that gentleman the cause of the excess of urates, I answered, it may probably be due to the bottle, which was not the same as the other three times, and which contained some kind of drug before it was filled. On October 15 I found nothing abnormal; whether it was a faulty analysis or not I could not tell. But the following three analyses, those of November 12, December 24, and especially that of February 4, 1893, were charged abundantly with excess of urates. Mr. N—— asked me what harm might arise, to which I responded, it may lead to stone in the bladder or gout; and as his brother has already had several attacks of gout, I told him he was likely to get it unless he changed his diet, which consisted of meat three times a day, and some spirits; of vegetables, which he absolutely disliked, he took very few potatoes. My advice was, not to stop his meats, beer, or wine, but to have plenty of vegetables at every meal, which of course itself must diminish the quantity of meat, the stomach having been satiated already by vegetables. Mr. N——, who is a graduate of the City College, a member of a downtown wholesale firm, and of good social standing, thought there was a difference between fluid and solid meat, abstained from the first, and with the latter he took sufficient vegetables. I was surprised not to find any trace of excess of urates at the next analysis, March 18, since which time the urine remained normal, Mr. N—— now being fond of vegetables.

The deposit of urates in the joints may probably be due to the following chemical changes: Uric acid, an animal product, found only in the carnivora, not herbivora, is produced only by animal and not by vegetable tissues. Consequently an increased supply of the material will increase the quantity of the output, *i. e.*, increased animal diet will increase the volume of uric acid in man. Finding no substances which, if vegetables were taken the free sulphuric acid contained in them would counteract, the excessive amount of the uric acid circulating in the body combines with the sodium (which with increased animal diet is also increased) of the synovial fluids to form the urate of soda, which is deposited. That the great toe is usually first involved may be due probably to the fact that the great toe joint is the least disturbed or exercised of all the other joints in the body and therefore any formation of deposits is undisturbed.

Related to gout, the difference being probably one of degree, is rheumatism. Here, as in gout, the joints are the site of disease; here, as in gout, there is "hyperacidity," or diminished alkalinity of the blood; here, as in gout, exists an ill proportion between meat and vegetables. Of the four patients I saw in Bellevue, 1, John C. O'C——, aged forty-three, admitted October 1, 1893; 2, Charles B——, admitted September 21, 1893; 3, Nicholas M——, admitted March 22, 1893; and 4, Alfred K——, admitted October 2, 1893—there were no more in our wards at that time—every one preferred meat, which they had taken several times a day, almost abstaining from vegetables; also to them meat was the nutritious food, the diet. In gout the excess of meat is apparent, easily detected, in rheumatism, a disease more of the lower class, the deficiency of vegetables is of a slow coming character. That in fishermen exposure to wet and cold should be regarded as the cause is not necessary; these people live on an animal diet almost exclusively. How well can each of the symptoms of rheumatism be explained should insufficiency of vegetables, or what is the same thing, excessive consumption of meat—the cause of the hyperacidity—be considered the etiological factor. Skin diseases and all other diseases that are the result of hyperacidity of the blood may thus have for their first, predisposing, if not exciting cause, an ill proportion betweeu meat and vegetables, the predominating one being meat.

If the foregoing be recognized, would we not be just in saying that as well as excess of meats, also excess of vegetables must induce sooner or later a pathological condition? that excess of vegetables or diminished quantity of meat may be the idiosyncrasy, predisposing or exciting cause, of another class of diseases?—*Medical Record.*

* Zeitschr. d. landw. Centralvereins d. Prov. Sachsen, 1875, p. 261.

† Zeitschr. f. Biologie, 1880, vol. 16, p. 55.

‡ Mittheil. aus d. chem. phys. Versuchs station d. Thierarzneischule zu Dresden.

## BANANA CULTURE IN JAMAICA.

In years gone by Jamaica, the Eldorado of the West Indies, was in a more prosperous state, when the sugar and rum traffic were productive of wealth; but, since introduction of beet root sugar into the European market, the cane sugar industry has rapidly declined.

Many large sugar estates, once richly productive, says Prof. W. S. Windle, in the current number of *To-Day*, are now deserted or devoted to other agricultural pursuits. During recent years, however, a comparatively new industry—that of banana culture—has arisen, which promises to replace the loss, in part at least. It is chiefly controlled by the Boston Fruit Company, which employs a line of eight or ten fruit steamers that ply, during the greater portion of the year, between the ports of Jamaica and the ports of Boston, Philadelphia, and Baltimore. The extent of the traffic may be estimated from the statement that each steamer averages a trip every three weeks, and carries from 12,000 to 20,000 bunches of bananas as a cargo. That the trade is rapidly growing is shown in the statistical report of Jamaica, which gives the shipment of bananas to the United States and Canada as follows: 301,991 bunches in 1889, 445,512 bunches in 1890; showing an increase of 143,521 bunches in one year.

To the student of nature, says Prof. Windle, a thrifty, full-grown banana plant appears as the grandest of herbaceous products. It makes a remarkably rapid growth, reaching the height of from nine to twelve feet in as many months. Its stem-like trunk of from four to six inches in diameter is formed of thick sheathing leaf-stalks, from the top of which spreads a loose cluster of immense long leaves. These are often fifteen inches in width and six feet in length, and, when first unfolded, are transparent and of a bright green color.

Their edges are smooth and unbroken until the broad, green surfaces, exposed to the sun, wind, and rain, become lacerated into transverse ribbons—wrecks only of early symmetry. The plants are grown annually from sprouts that spring from bulb-like roots around the parent stem. They need but little cultivation. Deeply rooted in the rich soil, watered by copious showers, and warmed by the rays of a genial sun, they grow most rapidly. In seven months a long spike, bearing clustered flowers, surrounded by colored bracts, shoots forth from the clustered leaves, and minute bananas soon appear at its base, leaving the sterile plummet-shaped portion of the spike to extend beyond the bunch that is now rapidly forming.

In nine or ten months after planting, the fruit is gathered and taken to market. The bunches are always cut from the plants while green, to secure transportation, and also to obtain better flavored and less fibrous fruit. They are conveyed to the nearest seaport in large spring wagons, drawn by oxen, to be stored in the slatted bins of large banana houses, where they await the arrival of the next fruit steamer.

The varieties of the banana were found by the author to be as numerous as the kinds of apple in our orchards at home. A small red one, the Chinese banana, is prized very highly in Jamaica and elsewhere for its delightful flavor. The Maiden and Baracoa varieties are also small and of a red color, valued alike for sweetness and delicacy of flavor.

Another member of the same genus is the plantain, which, in tropical America, is far more extensively used than the banana. It is seldom eaten raw, but is boiled or roasted, or cut into long, thin slices and fried in butter. The flavor of the plantain does not equal that of the banana, which is usually eaten, when ripe, directly from the bunch. Bananas, however, are often cooked, eaten as preserves, or made into delicious custards, ices, etc.

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## FRENCH CUSTOMS GUARDS AND FRENCH SMUGGLERS.

THE economic administration of France, recently transformed in the direction of protection, is synthesized, so to speak, in two categories of men—the smuggler, that scourge of the frontier, and the customs guard, his eternal enemy.

Let us first speak of the customs guard. Like nature itself, his uniform juxtaposes two colors that an old proverb declares to be irreconcilable—green and blue: a green jacket with red edging, a cap of the same color and trousers and overcoat of a bluish gray.

In order to become a customs guard, it is necessary to be an old soldier, to be able to exhibit a clean military record and to possess muscles capable of bending the bow of Diomede. Yet he is then but a candidate, the first year of service being a simple trial, at the expiration of which he is mercilessly discharged if he has not proved that he can combine the resolution of a Zouave with the sobriety of a Mussulman and the patience of a Mohican with the continence of a Carthusian. His probation having proved satisfactory, he is admitted to the honor of figuring on the muster roll, and then forms part of one of the thirty-eight customs battalions of the French army; for the customs guard is not only a gabeler, but also a soldier, who in time of war is called upon to perform the role of guide and flanker. He is the advance guard and suffers the first fire. In the East, for example, it is the customs stations that, at the opening of hostilities, are charged with the defense of the bridges and tunnels, with the mission of blowing them up if need be, with the guarding of the telegraphs and railways, with the maintaining of communications, etc.

There are two categories of guards: the coast guard and the frontier guard. The life and habits of the one are very different from those of the other. But it is not with the first that we have to do here; it is with his colleague, the customs guard of the frontier—the entirely conventional frontier of the North, which no mountain or river separates from the national territory. He passes his life, day and night, in ambuscade or in expeditions into the fields and woods, in sunshine, rain or snow. It often happens that, when there has been a great storm of wind, an entire month passes without the faithful gabeler having slept for a single time in his bed. He has been squatting somewhere with his companion in his sheep skin bag, under the starry sky or in a glacial rain, his eye open upon the immense plain, watching the horizon; for these guards always go in couples, sometimes in threes, but rarely more. They carry upon their backs their entire camping material, consisting of a folding frame of wood, a long sheep skin bag and their weapons, which are an ordnance revolver and a hooked lance. With very rare exceptions, the latter is the only weapon that is employed, for it is the rule that a frontier guard must allow himself to be three quarters killed before using his offensive arms against the bandits whom he is commissioned to seize.

CUSTOMS GUARDS STARTING FOR AN AMBUSCADE.

GUARDS ON THE WATCH.

Each has with him, moreover, a companion of a different species, a dog—a large, strong animal built for racing and fighting, and that scents fraud with an extraordinary intelligence.

At nightfall our four expeditionists leave the barracks, equipped from head to foot, and proceed to the post assigned to them, which is now in an open field, now at the back of a road, now at a crossing of pathways and now at the edge of a wood. Here the men install their wooden frames and spread out their bags, into which they enter up to the shoulders, the dogs squatting at their side. They watch and sleep alternately. When the keen sense of the dog perceives some unusual odor or murmur, the intelligent animal takes good care not to growl, but pushes his master with his nose or paw in order to attract his attention. The sentinel noiselessly rises in his camp bed, his eyes search the dark field, he strains his ear and all his superexcited faculties are directed toward a single object, like those of a savage upon the watch. Shadows are delineated in the darkness: one, two, three, walking in a wide triangle so as to be able to scatter at the least warning, or else an entire troop advancing in Indian file, one in the footsteps of another, so as to leave but a single imprint. The guard then awakens his companion by touching him with the hand, and both rush forward upon a sudden, and the pursuit begins. The chase may last a long time if the smuggler is far ahead. Upon the point of being seized, he drops his load so that he can run with greater speed. Often, too, there occurs the chance of a battle, which almost always takes place when the number of the pursued is greater than that of the pursuers. The blows fall thick and fast, for the smuggler knows that his liberty is at stake, and he stops at nothing. The customs guard, on the contrary, restrained by his orders, employs only his natural weapons. One does not hesitate to strike with all his might, even to kill, while the other wishes only to capture and bind, without wounding. Finally, strength failing and nearly beaten to death, the guard, without releasing his hold, succeeds in disengaging his revolver, which he fires into the air, as much to intimidate his enemies as to call his friends. A neighboring post comes to his aid and then all is up. The prisoners are bound and led to the guard house and the conquerors hobble away to have their wounds dressed and to mend their uniforms. It sometimes happens, however, that things do not become tragic, and that the smuggler surrenders without striking a blow. Sometimes, too, the band consists of children, who, at the sight of a uniform, scatter in all directions. The guards, then being obliged to hold back their dogs and with but one hand free, are content to capture two or three.

At the customs stations or offices permanently established at points where the roads and rivers cross the frontier, the incidents are naturally very different from those that occur in the field. Here there are no ambuscades, and the guard has orders to inspect passers-by occasionally and vehicles and boats often. This service, as peaceful as it appears, has also its risks. As regards individuals, there is nothing to be feared. It is not through here that smugglers enter the frontier, and the people passing normally from country to country, having or not having a box of matches or a package of tobacco in the depths of their clothing, know

IN INDIAN FILE UPON A RAILWAY.

beforehand that they will be vaguely felt of, and offer no resistance to the operation. Neither are the boats accustomed to show themselves restive or threatening. It is the wagon alone that is sometimes to be feared. This Pandora's box presents itself under under two aspects—the pacific and the warlike.

In the first case, it stops of its own accord in front of the customs office in order to submit itself to inspection. Very different is the wagon of attack, which is a true machine of war, driven by rough fellows always ready to exchange blows and passing the frontier on a full gallop.

It is only in the regular and sedentary service of the ports and railway stations that the customs guard is relatively happy. There, at least, he escapes the wearing fatigue and the continual perils of the life of a scout led by his colleagues. These are residences much envied in this little world, but, unfortunately, to which there are not many elected. When he has succeeded, more or less lamed, but living, in passing through inclemencies, adventures and battles, and has reached his fifty-fifth year, the guard is allowed to request his right to be retired. The time of service of this soldier always on an expedition lasts, therefore, ten years

PURSUIT OF A SMUGGLER.

longer than the military service, which ends at the age of forty-five.

Smugglers are not what a vain people supposes them to be; or rather they are no longer so. That is to say, they are not the smugglers of fiction—honest outside of the exercise of their functions, passionately fond of their adventurous vocation, and even capable of chivalrous sentiments. Those who undertake smuggling as a business are careful, as a general thing, not to operate in person, and of them having at hand a large number of persons without the least prejudice. It is these persons, very different from the specialist of former times, that now infest the frontier and render the approaches almost uninhabitable, especially in the vicinity of the great manufacturing centers, such as Roubaix and Tourcoing. Scarcely a day passes in which the journals of Lille do not mention the assassination of laborers returning from their work, the violation of women in the fields or on the highway, the partial demolition of ale houses, bloody frays, and robbery everywhere. This is because certain hamlets of the two sides of the frontier have become the haunts of bandits and other criminals who find in smuggling the wherewithal to sustain their debauches. It is especially in these centers that the undertakers of smuggling recruit their forces. At a number of points of the frontier, on Belgian territory, there are intermediate establishments in which they engage and collect together the carriers that they are in need of.

The destination of the goods that have deceived the vigilance of the customs is extremely variable. Sometimes they are deposited in barns or deserted cottages, and sometimes, too, in a farm house or a tavern, whose owner shows himself obliging for fear of vengeance, but, in most cases, with trusty guardians or even with the corresponding dealer of the master smuggler and the one for whom the merchandise is intended. The tacit or paid for complicity of the frontier population greatly facilitates the operations of the smugglers. Certain of the latter are desperate men, endowed with as much energy as adroitness, devoid of all scruples and shrinking before nothing. No one is shielded from their malice in the villages, and the isolated farm houses, taverns and cottages are less protected still. The professional smuggler finds here, almost to a certainty, the obligingness, directions and refuge that are necessary to him, and he thus organizes a perfect system of halting places, depots and telegraphic communications that aid him in baffling the efforts of the customs. Here it is waving linen that is supposed to be drying in the wind, here it is a light that is shining or not shining, according to agreement, and here again it is a hammer that beats the anvil in such or such a way; all this speaks a language that is understood by him, all this is a warning or a signal to him. The expedition starts out or does not start out, and the band passes here or there according as the warners have declared the moment propitious or have revealed the absence or presence of an ambuscade.

Some of the principal master smugglers proceed by convoys and have a small body of horses at their disposal. After the expedition has accomplished its mission the horses are immediately distributed among the farms of the vicinity, where they are employed gratuitously in field work—an advantage to both the farmer and the smuggler. The horse is not the only auxiliary of the smuggler; there is another and much more valuable one—the dog, which serves him both as a speed impeller and a carrier.

The running smuggler attaches the animal to his belt by a leash long enough to prevent its interfering with his own motions, and thus pulled forward, his running reaches an extraordinary degree of rapidity.

As a carrier, the dog is employed in packs. A man pulled along by a dog directs the pack, each animal of which is provided with trappings containing the merchandise, and is armed with a collar bristling with iron spikes. Expeditions of this kind are made with a punctuality and discipline that would be exacted in vain of human smugglers.

There are also dogs that act as "skirmishers," that is to say, isolatedly and without whippers-in. These undergo a special training consisting in treating them badly in their Belgian domicile and overwhelming them with attention and good meals at the house of the French correspondent. After receiving their load, and being set loose with many cuffs, they proceed at full speed toward the place where they know that a feast awaits them; and the game is played. Every canine smuggler of this kind is slaughtered when seized, and the customs guard cuts off its right front paw as an evidence of conviction.

Along with the smuggling thus systematically organized, there is another and permanent kind that is still more difficult to suppress, and that is effected daily by the employes of the factories and exploitations in the vicinage of the frontier, and each of whom, man, woman and child, carries his little contingent of fraud—coffee, tobacco, petroleum, etc., which he proceeds to disburden himself of at some grocery store for a few sous in return. This is known to the customs

'A HAND TO HAND ENCOUNTER WITH SMUGGLERS.

people, but it is difficult to remedy the trouble. While half a dozen persons are under examination, hundreds of others are passing scot-free. A number of small retail grocers have no other suppliers than these casual and anonymous smugglers.

There are two other categories of frauds practiced upon the customs that may be called the personal and the commercial The first, which is much the less important, is almost always effected by railway. Here again, it is necessary to distinguish between the occasional smuggler and the professional one. The latter, man or woman (for it is women in most cases who devote themselves to this sort of adventure), invariably employs the same means—specially prepared garments or double-bottomed valises. Now it is a gentleman who has substituted a lining of tobacco for his flannel waistcoat, or who, in a box simulating a book or an umbrella, or else in the depths of an ample mackintosh, carries either a hundred high priced Havana cigars or a stock of matches. Now it is a lady whose bustle is arranged like a closet or whose petticoats are like cartridge boxes.

The occasional smuggler is everybody. Among the thousands of travelers daily passing between Belgium and France, there is scarcely one who is not the possessor of a box of matches, a package of tobacco, or a few cigars. The Belgian matches are cheaper and better than the French, but the cigars are bad and the tobacco too.

However, it is not for any gain that these *corpus delicti* are brought home; it is through habit, for the "pleasure" of the thing, and sometimes also through mere fancy.

Commercial fraud is permanent and constitutes a sort of chronic complaint of the national finances and industries. It is effected at once by rail and wagon roads and waterways, either under the form of fallacious declarations or the secret introduction of prohibited or dutiable merchandise.

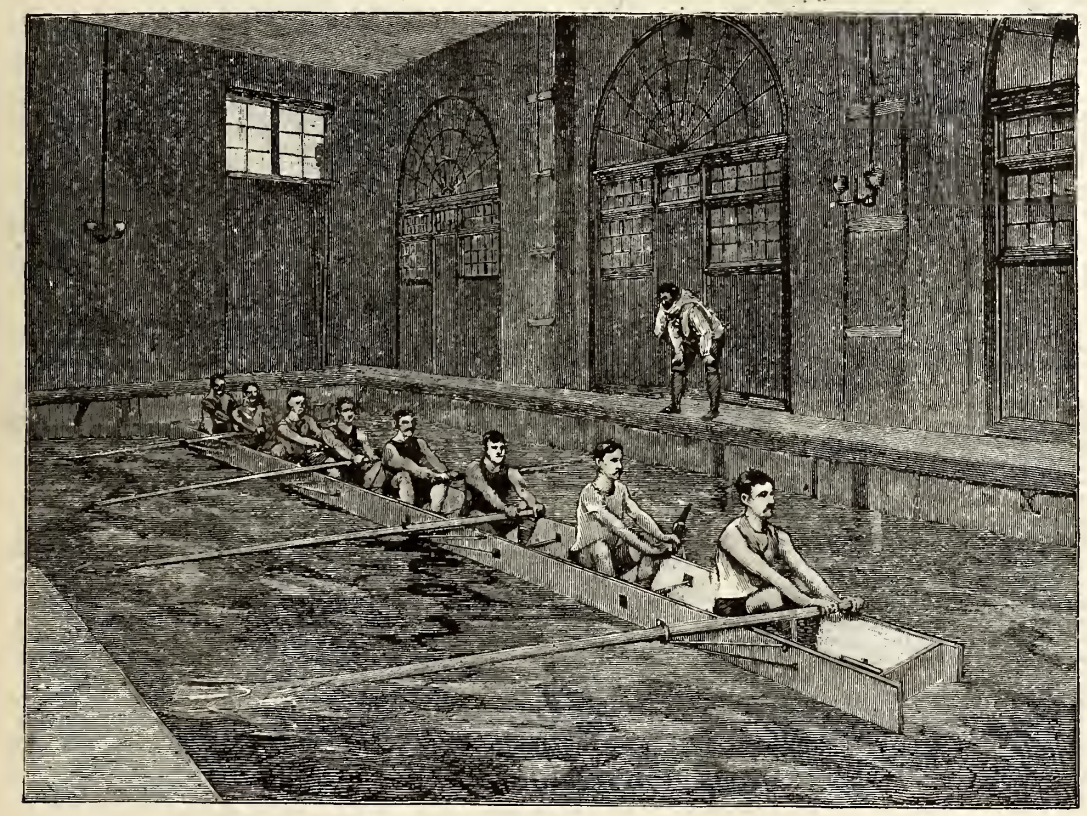
The extreme complication of the customs duties, the diversities of the taxes, and the difficulty presented by the discernment of the proportionality of the elements entering into the composition of manufactured pro-

ducts are so many causes to instigate and favor inaccurate declarations. It is naturally to the interest of importers or commission agents to pay as low a duty as possible, because both are benefited by the difference. If it is a question of textiles, deception is practiced in the numbering of the threads, or else fine threads, which pay a higher duty, are adroitly mixed with others in the same bale. If it is mixed fabrics, the lowest dutiable material is asserted to be dominant therein.

If it requires great experience on the part of the customs examiners to determine such classifications with accuracy, at least as much perspicacity is indispensable to baffle the ruses of occult importers. How suspect, for example, that the carcass of a horse has been eviscerated and then stuffed with some hundreds of pounds of tobacco; that blocks of stone or chimney brackets have been patiently hollowed out and converted into reservoirs of alcohol; that such or such a wagon has hollow shafts or wheels filled with contraband materials; that secret boxes have been established under the seats of such or such a car; that such or such a cart has double wheels; that cavities have been formed in such or such a locomotive, between the wheels and the cylinders or under the foot boards? The entire sagacity of the world would become powerless to triumph over such ingenuity did not the custom house have spies on the other side of the frontier, who keep it informed, and if, on another hand, there were no Judases among the smugglers, all ready to reveal the tricks in order to handle the reward offered to informers. Such tricks, continually varied and renewed, are too numerous to be cited here—so numerous, indeed, that a description of them would form a volume as bulky as a Greek dictionary.

## WINTER TRAINING FOR THE BOAT RACE.

THERE are several things in this life pleasanter than practicing for the Inter-University boat race. Putting aside the glory, it is infinitely less enjoyable than



WINTER BOAT RACE TRAINING.

training for the May races, as the preparation for the great Easter race has to be gone through in the winter. The trial eights occupy November and the early part of December, and at neither university is the weather ever anything but abominable during these months. Then the eights are made up as early in January as the presidents can get their men together, and the opening months of the year are, as a rule, seasons to be remembered both at Oxford and Cambridge. Still, it is but seldom that the boats are stopped by the ice, and nothing short of a sharp frost ever prevents the coach from taking out his crew. In America, where winter is more regular in its habits, and according to all accounts, does not usually sandwich a spring day between two midwinter days, the crews practicing for the Yale and Harvard race take advantage of an excellent invention for securing open water even in the depth of winter. This device, as the illustration shows, is a large tank in which is moored the shell of a boat, so arranged that it gives under the strokes of the crew, but always returns to its original position as the men swing forward after each stroke. Of course, the men cannot lift their boat along as they do on a river, and the work is slightly different, as the pivot of leverage is the rowlock, and not the blade in the water, but the shifting of the power makes no difference to the crew, except that it makes the work a little heavier, while it enables them to practice regularly under the eye of the coach, who can walk up and down the edge and rate his men comfortably without having to keep one eye on the towpath along which his old horse is trotting. It is probable that training in a tank like this would tend to deprive the stroke of its elasticity and spring, but, even if this be so, the drawback would be quite compensated for by the freshness and the liveliness of the boat which the men would feel in rowing on a running stream, when once they had got rid of the idea that their craft was slipping away from underneath them. In England the weather is never severe enough to make the employment of such an invention as this necessary, though there are days when the water freezes on the blade of the oar, and the keen wind comes whistling across the lowlying meadows and driving the flakes of snow like frozen pellets through the zephyr jersey, in which a man might almost be pardoned for looking with envy on the American oarsmen in their comfortable roofed-in tank. Training for the Inter-University boat race is not, as Albert Smith remarked, a bed *ros: fol:* but all its hardships are cheerfully endured for the honor of even being ninth man to the chosen eight, not to speak of rowing in the boat itself.—*The Graphic, London.*

## ESSAY ON BREAD MAKING.

THE following essay by Mr. W. T. Callard was read at the annual examination in bread making held by the National Association of British Master Bakers and Confectioners, and is reported by the *British Baker and Confectioner:*

### THE BEST METHOD OF FLOUR BLENDING FOR SPONGING AND DOUGHING PURPOSES.

The difficulty of flour blending to the baker lies in the fact that the flours he buys are already blends of two or more varieties of wheat, which seems to be a necessity of modern milling, where the softer, damper sorts cannot be milled separately. It is possible for the large buyers to buy certain distinct lines of flour made from certain characteristic wheats, but for a small buyer it is not always feasible.

The first or rather all-important fact to be considered when making a blend is price. This must be dependent to a large extent on the yield of various brands, and should be adjusted over the whole blend, including both sponge and dough; for, according to the state of the market, it is often advisable to use flours which are high in price per sack to supply the deficiency of those which may be bought at lower prices, but lacking in one particular.

Varying harvests considerably affect not only the relative prices of flours, but also their respective color, flavor, and strength. It is, therefore, necessary to take a standard of these three qualities of the loaf required, and select flours accordingly.

Supposing ten points were given for the loaf, they would be apportioned as follows: Three points for size, three points for color, and four points for flavor.

Each flour should be tested separately, and marks given for it under these three different headings, and if any one attribute be deficient, a flour which possesses the missing attribute in excess should be used to supply the deficiency, always bearing in mind yield and price. The desideratum is to always have the blend of flours of equal color, flavor, and strength, and by apportioning a certain value to every flour under each of the three headings, the values may be arranged respectively, according to the class of bread required. To do this it is absolutely necessary to test each brand separately, the baking test to be preferred, and to award the relative points according to the result of test.

The flours in the example would be chosen in this ratio:

| | Strength. | Color. | Flavor. | |
|---|---|---|---|---|
| Sponge flours . | 5 points | 2 points | 3 points | = 10 points. |
| Dough " .. | 2 " | 3 " | 5 " | = 10 " |

For sponging, I should prefer a Minnesota Patent; failing that, an English Milled Patent, and for doughing a mixture of flours or flour from these following typical wheats: Five parts for color and flavor, good English (Somerset) wheats; two parts for strength, Northern Duluths; one part California, for richness of color or bloom; and the other two parts selected according to the market values, probably one Ghirka and one Oregon or Kansas, or perhaps two Ghirkas entirely, according to the market value.

As typical flours for the two stages, let me mention for—

*Sponging.*—Minnesota Patents (such as Pillsbury's Best), some best Russians, Duluths, and most spring wheat patents. Either one would be good by itself, or a blend of any two in the last three, in equal proportions.

*Doughing.*—Oregons, Californians, Winter Wheat Patents, English, Kansas, and other softer varieties; if any Indian be used, it should be added at this stage.

A very small proportion of doughing flours may be used in sponge stage to shorten the time of fermentation, or to start the yeast if it should be required, but it is not a practice to be recommended.

A larger proportion of sponge flours may be used in the dough stage, according to price and type of loaf required; but if a large proportion of very strong flours be used at this stage, more yeast must be used per sack, or the peptonization of the gluten will not be complete, and the risk will be run of indigestible bread, as well as the crust being "red" or "foxy." This is a case in which malt extract may be used with advantage.

If straight grade (whole flour from wheat) milling should ever become general, this process of blending will be much simplified, but under present conditions of trade such a desirable object is not likely to be realized. Then the same system would apply, but the difficulty of blending flours which have already been blended to suit the merchant would cease, as flours from certain wheats are far more likely to maintain their characteristics than millers' mixtures. Even then judgment as to the relative value of different harvests must be considered.

After the blend has been carefully selected, let it be thoroughly mixed in a large bin, with maltsters' shovels, by hand, or any mechanical contrivance, but any machine which by its action unduly presses the flour together should be avoided. When this operation is completed it should be carefully sifted and weighed into convenient quantities, and stored in sacks or bins, and allowed to remain for some days—not less than three, but preferably a week—in order that the dry and moist flours may assimilate the moisture, and the flavor permeate the whole, or, in other words, to allow the flour to "mellow." Immediately before using, the flour should be sifted again to insure perfect mixture in the dough machine.

In establishments provided with an automatic weigher over the kneader, which weighs flour as required, the weighing into sacks may be dispensed with, but with flour weighed and water measured in a specially gauged cistern, placed conveniently near the kneader, we possess a great safeguard against doughs of variable size, and consequently pile, texture, and volume of loaf.

### THE BEST METHOD OF FERMENTATION FOR BREAD.

The following five systems are all capable of producing good bread, and it must be left to circumstances and choice to determine which is the best. 1. Sponge and dough. 2. Ferment, sponge, and dough. 3. Ferment and dough. 4. Dough made to lie four hours. 5. Dough made to lie twelve hours. Each system has its advantages and disadvantages; they need slightly different flours, and also some of them give much better results with certain yeasts than others, and it must be according to the requirements that the selection is made.

I prefer under ordinary conditions that of sponge and dough; first, because of its simplicity; second, because of the ease with which it can be conducted; third, because of the opportunities it affords of using dry, strong flour, most favorably, as well as those weaker and of better flavor, with a doubly good result, and also on account of the comparatively small cost for yeast compared with some other systems, as the yeasts will reproduce in a slack sponge. It is also most convenient for working hours. As I have detailed this method in a former part of this paper, I will make no further reference to it beyond that the quantities of yeast and salt are eight to nine ounces of yeast to the sack, and salt three pounds per sack, eight ounces of which is added to the sponge. No. 2 method is practically the same as the above, only better adapted to a lower or weaker kind of yeast most suitable for those employing malt and hop, patent, composition or brewers' barms. With any of the composition variety the ferment should be allowed five or six hours. These yeasts are found to be slow and unreliable, partly on account of the atmospheric conditions surrounding its manufacture. It is impossible to expect, in an ordinary bakery, that such a delicate operation as yeast making can be safely carried out, owing to the elaborate appliances needed to cool the mashes rapidly, and to protect the worts from obnoxious germs.

These uncertainties render it only suitable to be used where fresh and regular supplies of compressed yeast cannot be depended on.

3. *Ferment and Dough.*—This method is suited to conditions where space is a very considerable object, as with very few tubs and a couple of troughs a very fair-sized trade may be done, and one man may control all the ferments, etc., even for a large trade. It is contended that the fermentation being completed in a short time—three and a half to four hours—there is much less chance of souring, but that this is a fallacy may be noted by the large quantity of sour bread produced by these methods. It frequently happens that there is a delay of some minutes in taking a ripe ferment, which matures in from twenty-five to fifty minutes, and then when the yeast has used up all its food (glucose) is a favorable opportunity for souring. Certainly much of the bread made by this process is of bad shape and color, especially in the crust. The cost of yeast (from three pounds per sack) must be considered, as also the fact that the doughs lie three hours, during which time they require three "turns." Salt two and one-half pounds per sack.

4. All night doughs are convenient in that there is no delay in taking them when work is begun in the early morning, but I have been unable to satisfy myself with the flavor produced by this method, not being fresh nor the texture fine, while the crust is discolored; in fact, the bread suggests imperfect peptonization. Yeast two and one-half pounds per sack, three pounds salt per sack.

5. Four or four and a half hours is the time occupied in working through fast doughs suitable for fancy breads, which are eaten early and not kept any length of time. It may be adapted to loaf bread, but is only successful when very slack doughs are used (say eighteen gallons or even more per sack), and the doughs require four or five turns. The softness of the dough precludes its being used for high crusty cottages, but is eminently suited for long rolls. The great objection

to this method is the great cost of yeast, being six pounds per sack; also so much skill is needed in determining the ripeness of the dough that it is liable to be placed in the oven before it is ripe, or allowed to ferment too long and spoil. Salt four pounds per sack. The cost of yeast practically places it out of the market for loaf bread.

I have not treated of the Scotch methods of bread making, because, as a rule, they are not appreciated, except when very strong flours are used. The Parisian barms are made of scalded flour mixed with an infusion of malt, and yeast added when cold, and allowed to ferment for three or four days, when the sponges (very slack) are allowed to lie for fourteen to sixteen hours and the dough one and a quarter hours. Salt six pounds per sack. This usually baked in closely packed loaves, and produces a fine pile. The usual objection to the bread made by this system is its acidity or even sourness. Two pounds of the salt is added in the sponge.

Aerated bread is simply flour and water made into dough, and mechanically charged under pressure with carbonic acid gas. This is not to be recommended, on account of the indigestible nature of the bread produced, and the uncooked flavor it possesses, owing to the lack of peptonizing agents. After long and repeated trials, this kind of bread seems rapidly going out of production as a commercial article.

## PUT YOUR HEAD TO THE ENGINE.

"How will you have your feet?" the porter asked in a Wagner car coming from Buffalo.

"Feet to the engine," said the passenger.

"If you travel much you'll have your head put next to the engine," said the colored man.

"No," said the passenger, "I am afraid there might be a collision, and then I'd be thrown with all my weight against my head." The porter chuckled.

"I beg pardon, boss," said he, "but I notice dat all de railroad men has their heads put toward de engine—and all the commercial travelers also. The biggest arguments is in favor of doing that way. In the first place, there ain't many head-on collisions. There's more danger of a rear-end collision. The reason is that every passenger train has its own right of way, and runs regularly every night, and is looked out for by all the trains that's running ahead of it. Therefore the most danger is from something behind which don't know when we have stopped or broke something, and which runs into us unexpectedly. There ain't any one looking out for any kind of collisions, 'cause when they come it matters mighty little which end you're putting forward—your head or your feet—but if you insist on looking out for 'em from behind—I'm a-telling you."

"Any more arguments?"

"Got plenty more arguments, boss. You don't want to sleep with your feet toward the engine, because if you do the draught through the car blows right agin your head, and when it gets cold at night your head and chest are exposed. Put your head toward the engine and you feel cool without gitting in no draught. It's just the same way in summer. If you sleep with your feet toward the engine you can't have your windows open, with the screen in 'em, without getting the wind and fine dust right in your face, whereas if you sleep with your head to the engine you get the cool air and no draught and dust."

"Is that all you know?"

"No, boss; I hain't told you the biggest argument yet why you should have your head made up toward the locomotive. The most serious thing of all is the circulation of the blood in your body. You been having your feet made up toward the engine, eh? Well, I reckon you don't never sleep very well in the cars, do you? Your night's res' is usually broken, ain't it? Well, sir, lemme make up your head to the engine an' you'll sleep like you was a baby. Dat's because the motion of the train is so strong and steady that it sends all your blood toward the end that's furthest from the engine. Put your feet to the engine, and all your blood rushes straight to your head and gives you a restless night. Put your head to the engine and the blood goes away from your head, leaving it cool and easy so as you can res' like a child."

"Put my head toward the engine and stop talking, will you?"

"Yes, sir; all right, sir; anything you say, sir. You wont gredge me dat quarter in the morning, I'm a-tellin' you."

[A lapse of half an hour. Then a voice from between curtains. It addresses the porter.]

"Solomon; Diogenes, porter! Any arguments as to what part of a train is the safest?"

"There aren't no use of arguments 'bout dat, sir. The safest place on a train is the middle of the middle car on the side furthest from the other track."

"Good night, Cicero."

## THE TRAVELING BOTTLE AND GLASS.

Upon a table, at the rising of the curtain, are observed a bottle and a glass, the latter full of wine up to the brim. The prestidigitator pours into the bottle half of the liquid, "which otherwise," he remarks, "might slop over during the voyage." Then two cylinders of the same diameter as the bottle are made before the eyes of the spectators out of two sheets of paper and four pins.

These are designed to cover the bottle and the glass, which have been separated from each other by a short interval. (Fig. 1.) Instantaneously, and in an invisible manner, the two objects change place twice, and yet there is never anything in the paper cylinders, which are, ostensibly, torn into a hundred bits.

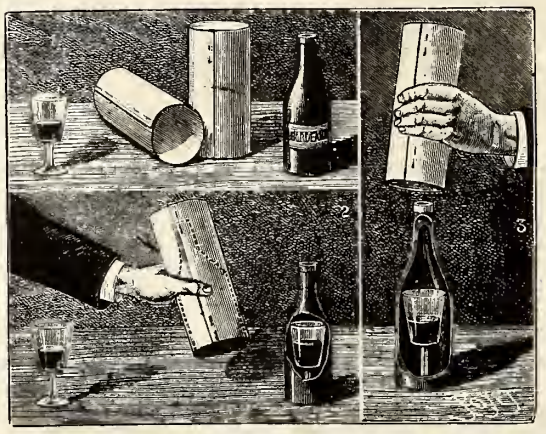
Fig. 3 unravels the mystery. The bottle is of varnished tin, and bottomless. It covers a second bottle that is similar, but a little smaller, and in the center there is concealed a glass similar to the one that has been shown, but empty. It receives the half of the wine that was poured from the first glass. This operation necessarily contributes toward convincing the spectators that they have before them an ordinary bottle provided with a bottom and capable of containing a liquid.

The operator first covers the bottle with one of the paper cylinders as if to ascertain whether it has the proper diameter, but immediately removes it and places it upright upon the table.

What no one can suspect, however, he has at the same time lifted the first bottle by slightly compressing the paper. It is then the second bottle that is seen, and which is precisely like the other, the labels of both being turned toward the same side and exhibiting a slight tear or a few identical spots designed to aid in the deception.

The operator, having finished his palaver, places the empty cylinder upon the second bottle and covers the glass with the one in which the first bottle is concealed. (Fig. 2.) The magic wand is then brought into play, and after this the paper cylinder alone is lifted at the side where the glass was in the first place seen, while at the opposite side, the bottle, on being removed, exposes the glass that it concealed. The operation is begun over again in the opposite direction; and, finally, under pretense of once again showing that either paper cylinder can be used indifferently, the operator replaces upon the second bottle the cylinder that still contains the first one, unbeknown to the spectators.

This is done so rapidly that the action is apparently



TRICK WITH A BOTTLE AND GLASS OF WINE.

but a gesture, but nothing more is needed to free the cylinder of its contents and re-establish things in their former state.—*La Nature.*

[From the Kew Bulletin.]

## POLING IN AGAVE PLANTS.

The progress of the fiber industry in the Bahamas has been fully noticed during the last four years in the pages of the *Kew Bulletin.* At the present time the earlier plantations are approaching maturity, and it is anticipated by those interested in the subject that the export of fiber on a commercial scale will probably begin next year.

In the meantime a question of some importance has arisen in regard to the duration of life of the particular sort of *Agave* cultivated for fiber purposes in the Bahamas.

This is botanically known as *Agave rigida*, var. *sisalana.* It is a dark green, smooth-leaved sort (with no marginal teeth), originally introduced, either directly or indirectly, from Yucatan. There it is known under the aboriginal name of Yaxci.

The plant more generally cultivated for fiber in Yucatan is a glaucous-leaved sort, armed with small, black, marginal teeth (*Agave rigida*, var. *elongata*), known locally as Sacqui. The Bahamas plant, Yaxci, is still also found in Yucatan, but apparently it is not specially selected for general cultivation.

Of *Agave* plants, a familiar example, grown in greenhouses in this country, and sometimes put out for decorative purposes during the summer months on lawns and terraces, is that commonly called the American aloe (*Agave Americana*). Such plants produce nothing but leaves for the greater part of their life. In this state they may last for many years. In some species there are also occasionally produced root suckers, which afford a ready means of increasing the plant. This, however, is a purely vegetative reproduction. The exact life period of agaves in northern latitudes may vary from 10 to possibly 50 years or more. On account of this exceptional longevity among succulent plants they are sometimes called century plants. In the tropics, grown under natural conditions, these plants seldom last longer than 7 to 12 or 15 years. Sooner or later, however, within the periods above mentioned, and depending on conditions under which they are placed, they throw up a "pole" or flowering stem. On this will successively appear the flowers, the capsules bearing seed, and possibly also numerous bulbils. In some species there are produced abundant seeds, but no bulbils; in others there are produced bulbils only, and no seed. The ripening of the seed or production of bulbils, whichever may be the normal habit, brings the life of the plant to a close. After this the whole plant withers and dies.

The question raised in the Bahamas, and respecting which the aid of Kew has been sought, has reference to the exact length of time the Yaxci (*Agave rigida*, var. *sisalana*) may be expected to last in the leaf state. In other words, how long can the plant be made available to the planter for the production of fiber? The matter is naturally one of great interest to the Bahamas people, for on it hangs the success of their plantations. The result of the inquiry at Kew is given in the following correspondence. It is so far satisfactory that, with care and judgment on the part of those directly in charge of the plantations, there need be no greater cause of anxiety in the Bahamas than has been felt during the last thirty years in Yucatan, for plants that have poled might easily be replaced from time to time by strong, healthy "supplies" from nurseries, and the work of the plantations need not at any time be seriously interrupted.

### MR. NEVILLE CHAMBERLAIN TO ROYAL GARDENS, KEW.

*Memorandum.*

July 26, 1893.

Information has been received from the Bahamas of a somewhat serious nature in reference to the Sisal industry. It will be remembered that in the wild state these plants pole when about seven years old, but it was supposed that the cutting of their leaves when cultivated would delay the poling and prolong the life of the plant, as is said to be the case with the Yucatan variety. It is said, however, from observation of old plants in the Bahamas, that cutting makes no difference to the life of the plants, which seldom exceeds seven years. As four years at least are needed for the growth of the plants before they are fit for cutting, this only leaves between two and three years of cropping, in which the planter must recover all the capital expended in their cultivation. Any suggestions by which the life of the plants might be prolonged and poling prevented are invited, as the early poling will gravely affect the success of the industry. N. C.

### THE MONROE FIBER CO., LIMITED, TO ROYAL GARDENS, KEW.

Abaco, Bahamas, July 20, 1893.

Dear Sir: The interest shown by your department in the fiber industry of this colony, and the valuable information you have afforded in connection with the plant, have prompted me to submit the following questions, which deal with points of prime importance to those engaged in its cultivation. In fact, I do not know to whom else to apply, for our plant is undoubtedly different from that commonly grown in Yucatan, and no one in the Bahamas seems able to speak with certainty upon the subject under review.

Our plant, or "Bahamas hemp," as it is now termed, is an Agave with dark green leaves, which are spineless except for a thorn at the tip. From all accounts, it is identical with the "Yaxci," of Mexico.

1. The life of the "Sacqui," which is that generally grown in Yucatan, is said to be from eight to sixteen years after cutting has been begun. Can you tell me whether our variety enjoys as long a life or not?

2. Do Agaves put out during their life a certain fixed number of leaves, the normal quantity varying but little between plants of the same species, or is there no regular limitation in this respect?

3. If the output of leaves on a plant is variable, would cutting them as they mature be likely to increase it, and, judging from analogy or otherwise, ought the cutting to be made several times a year or at any particular seasons? Also, would cutting the leaves have the effect of prolonging the life of the plant by retarding its poling?

It may seem strange to ask for such information when we have the plant here growing under our eyes, but it is only now reaching the cutting stage on most of the plantations, and where it has been longer established there unfortunately does not seem to have been much observation bestowed upon its nature or the circumstances of its growth.

You can easily perceive the necessity we are under of obtaining a clear understanding on the points raised in this letter, as, for instance, when it will be advisable to reset the fields with young plants so as to be ready to take the place of the old ones as the latter die off, and also how to prolong the life and increase the yield as much as possible. I need not say how thankfully any assistance you may kindly give in this direction will be received.

Yours, very obediently,
(Signed) J. Gurdon.

The Director, Royal Gardens, Kew.

### ROYAL GARDENS, KEW, TO MR. AUSTEN CHAMBERLAIN, M.P.

Royal Gardens, Kew, August 18, 1893.

Dear Mr. Chamberlain: When your brother was last at Kew he left with me a memorandum respecting the age at which plants of the Yaxci, of Yucatan, now known as the "Bahamas Pita" or Sisal, reach their maturity. He also asked whether anything could be done by processes of cultivation to retard the poling or the appearance of the flowering panicle, which it is well known marks the duration of the life of the plant.

2. There is apparently very little reliable information obtainable in regard to the age at which these plants flower. In fact, in the whole of the literature of the subject the references are very few and the language is vague and inconclusive. In the inclosed memorandum I have given a brief summary of what has been recently published, and it may be possible to draw some general conclusions from the facts therein stated.

3. The observations in regard to the Sacqui of Yucatan do not, it is true, bear directly upon the subject. But as the Yaxci or Bahamas Pita is only a variety of the same species, it is improbable it should differ in any marked degree from that plant. The length of time that elapses previous to flowering in Agave plants may in some degree be affected by soil and climate, but as a general process of growth and with plants cultivated normally over a large area, the experience in Yucatan may not be far from what will ultimately obtain in the Bahamas.

4. The latest information from Yucatan is furnished by Mr. Pierce, the vice consul at Merida. He states that "a hemp plantation in Yucatan lasts for some fifteen years." This is not conclusive as regards the age of the individual plants. It merely shows that while some of the original plants may pole at one age and some at another, their places are so filled up from time to time by new plants that the whole undertaking receives no serious check up to about the fifteenth year.

5. It appears to be recognized in Yucatan as the result of experience (without apparently any reference to the determining causes) that poling is encouraged among these plants if the leaves are left uncut for any length of time after they have arrived at maturity. There is little or no scientific basis for this opinion, and experience at the Bahamas should be carefully recorded if tending in that direction.

6. They also believe in Yucatan that if the root suckers, which are abundantly thrown out round the base, are allowed to remain attached for a long period, they tend to exhaust the parent plant and accelerate the period of poling. Such suckers no doubt divert the strength of the parent plant, and if allowed to remain too long either of two things must happen—the parent plant will produce fewer and smaller leaves or its period of maturity will be hastened. The practical outcome of this is the suggestion that such suckers

as are necessary for supplying the plantation should be removed when large enough into nurseries and all others, not required, should be removed periodically and thrown away.

7. Mr. Stoddart, it is noticed, records that the Yucatan people are very particular when cutting the leaves to cut them as close as possible to the stem of the plant. In other words, they consider it undesirable to leave any portion of the base of the leaf to form what is called in tree-pruning a "snag" on the parent plant. A certain degree of "snag" is inevitable. This, however, afterward falls off, when dry, leaving the central stem of the plant eventually quite clean. I am not prepared to attach much importance to this matter in relation to poling. It is undesirable as a matter of economy in fiber, and it may also have some effect on the general health of the plant. It certainly would produce an untidy appearance in the up-keep of the plantation, and altogether the practice of close cutting the leaves should be systematically carried out.

8. Coming now to the Sisal plant as known in Florida and the Bahamas, it is evident that an impression prevails both in Florida and the Bahamas that some of these plants have flowered at about the seventh year after planting. The instances recorded are given in the accompanying memorandum. They are, however, not conclusive. The exact history of the suckers before they were put out, and the treatment they afterward received in regard to cutting the leaves and allowing the suckers to remain on indefinitely, are not given. All these are important factors to be considered before an opinion can be formed. The result of further and wider experience will probably show that some plants may pole at seven years, others at a later period. It is unlikely, if properly treated, that they will all pole over a large plantation at the same time. If the plantation is carefully watched and fresh plants are put in immediately the fact is realized, or at the first sign of poling, there need be little interference with the work of the plantation.

9. It is essential that fresh plants in large numbers be grown on in nurseries with the view of supplying any vacancies caused by poling. Also the pole should be cut out as soon as it appears above the leaves, in order that the leaves already formed should be ripened before the plant dies. This practically means that the plant would be kept available for yielding fiber for nearly a year later than it otherwise would be.

10. There is another point to be briefly noticed. While it is important that all the mature leaves be cut when they have attained full development, great care should be taken that the immature leaves are not also cut. The regular cutting of the fully matured leaves might possibly tend, as mentioned above, to prolong the vegetative life of the plant and retard poling. Theoretically, however, there is no ground for such a supposition. On the other hand, the cutting of immature leaves would certainly have a contrary effect. The plant would be likely to be weakened by the process, and the subsequent leaves borne by it would be smaller and weaker. The exact period when the leaves are to be cut should be carefully studied. As a general rule the leaves are ripening when they are gradually falling from the erect into the horizontal position on the plant. Also there may be some indication in the color of the leaves. These are, however, matters to be decided on the spot by careful and skillful people. It is only necessary here to draw attention to them, and to state that both the life of the plants and the quality of the fiber, in other words, the success of the whole undertaking, may not improbably depend upon them.

I am, etc.,

(Signed) D. MORRIS.

J. Austen Chamberlain, Esq., M.P.,
40 Prince's Gardens, S. W.

*Memorandum.*

THE LIFE OF SISAL HEMP PLANTS.

There are numerous species of Agave (popularly called aloes) belonging to the natural order *Amaryllideæ*. They are almost all monocarpic perennials; that is, they grow on for a number of years producing leaves only; finally they flower, and this they do but once in their life, and that period is apparently determined by the nature of their environment. Usually Agaves under cultivation in this country live to a great age. On this account they are sometimes called century plants. In their native country they live for seven to fifteen years. When once the monocarpic species have flowered and produced seeds or bulbils (pole plants) they die. The following notes refer to the Sacqui (*Agave rigida*, var. *elongata*) and to the Yaxci or Bahamas Pita (*Agave rigida*, var. *sisalana*):

(*a.*) Mr. Stoddart says, "The plant (the Sacqui of Yucatan) lasts . . . for at least twenty-five years in a cutting state, depending on the soil and treatment." To renew a plantation after the original plants have become exhausted, "it is usual to plant at proper distances, by the sides of the old plants or between them, young shoots which three years afterward (and upon the failure of the old ones) will be fit for cutting." A new field will thus "be kept up without any loss of time or suspension of work." (Sisal Hemp, its Adaptation to Jamaica, p. 4.)

(*b.*) Mr. Stoddart describes the poling as follows: "This happens when the plant has arrived at cutting age *and the plants are not cut.*" . . . "When the pole begins to come out and gains a length of about three or four feet, it is customary to cut it off close without injuring the leaves. These leaves will then mature and be fit to be taken off before the plant dies." (l.c. p. 7)

(*c.*) Poling appears to be accelerated (1) by the leaves not being cut when they have arrived at maturity, (2) by the plants being exhausted by numerous suckers allowed to remain around their base, (3) by careless cutting of the leaves. Stoddart on this latter point says: "If the stump (or base) of the leaf be left of any length on the trunk it seriously injures the plant, spoils its vigor, and *makes its existence a short one.*" (l.c p. 7.)

(*d.*) Mr. Pierce says: "A hemp plantation in Yucatan lasts for some fifteen years. . . . On good land the crop commences in four years or earlier, while on rocky ground from six years or more." (F. O. Report, 1892, p. 2.)

(*e.*) Mr. Dodge, discussing the Pita or Yaxci plant of Florida and Bahamas, remarks that in one instance, on very poor soil, he noticed that "a long row of plants set out ten years ago to form a boundary line had hardly made any growth." (Report of C. R. Dodge on "Fiber Investigation in the United States." Washington, 1893, p. 21.)

Mr. C. T. McCarty, of Ankona, Florida, says: "With us *Agave sisalana* sends up its pole at seven years on our best lands. . . . So far as the plant is concerned, the 'poor land' theory has no foundation in this locality. Our strongest and finest plants are on our best land." (Dodge, l.c. p. 15.)

(*f.*) Mr. Merrick Shaw, Polk County, Florida, describes a Sisal hemp plant under his observation as follows: "The original plant growing on the soil, of which a sample was sent, poled at seven years old. Twenty layers of leaves had been cut from this plant, and the lowest of those remaining measured 5 ft. 9 in. in length by 5 in. in width at the broadest part. About 100 suckers had been removed from (the base of) this plant and planted elsewhere." (Dodge, l.c. p. 17)

(*g.*) Mr. Dodge figures and describes a plant with leaves barely a foot long, which had thrown up a slender pole to a height of eight feet or more. He adds: "I was informed by residents on Indian Key that this premature blossoming of a young plant or sucker *while yet attached to the parent root* is not of uncommon occurrenc ." (Dodge, l.c. p. 18.)

Kew, August 16, 1893. D. M.

[*Note added.*—The plant cultivated in Mauritius, and yielding what is known as Mauritius hemp, is the green or fœtid aloe (*Furcræa gigantea*). The value of the exports are about £50,000 annually. This plant is similar to an *Agave*, both in appearance and habit, and it also produces numerous bulbils or pole plants after flowering. The experience in Mauritius with regard to poling of the *Furcræa* has a striking resemblance to what has been observed in regard to the Agave in Yucatan. M. de Chazal, who has written an account of "*Le fibre d'Aloes*" (Mauritius, 1882), states (p. 21) that "the plants generally pole at the age of seven or eight years; they can, therefore, be cut four or five times before poling and before it is necessary to replace them." On the same subject Mr. John Horne, F.L.S., late Director of Gardens and Forests in Mauritius, writes under date of September 4, 1893, as follows: "The life of *Furcræa gigantea* in Mauritius is from seven to ten years; . . . as many of the plants flower three to four years earlier than others, the leaves of the seedlings (or pole plants) from these are fit for cutting when the late flowering plants are dying out, so cutting once begun on a plantation may be said to be continuous. . . . Supplying among old plants should be done in time so that as the old ones die out cutting from the young ones should begin. Over-cutting the leaves is common in Mauritius. This is generally held to be injurious to the plants, weakening their growth and causing them to flower and die prematurely. People in Mauritius say that by cutting only the mature leaves the growth of the plants is not weakened, and thus large fine leaves are obtained, yielding long fiber of the finest quality. But I have never heard the idea expressed that such a manner of cutting prolonged the life of the plant beyond what I might call the natural limits. It is said in Mauritius that over-cutting weakens the plants and causes them to flower and die prematurely, so it may be also said in Yucatan that cutting only the mature leaves prolongs the life of the plants to its natural limits. It comes to this, that what is said not to shorten the life of the plants in Mauritius is said to lengthen it in Yucatan—a case of arriving at the same place from opposite directions."]

## POINCIANA GILLIESII.

As an out-of-doors shrub in the mildest parts of Britain, there is nothing which approaches Poinciana Gilliesii for the beauty of its yellow and scarlet flowers. We are indebted to the kindness of the Rev. H. Ewbank, St. John's, Ryde, Isle of Wight, for the flowering shoots from which our engraving was prepared, and who had a strong growing example in full blossom at the end of the month of September, and in October last year.

About London the plant succeeds against a warm wall, flowering in July, and later, according to the season, some slight protection being afforded it during the winter. It is a native of the province of Mendoza, in Chile, where it is found in sheltered situations, between the rivers Diamante and Atuel, and also along the western side of the Rio Quarto. The flowers have a sickly smell, and are supposed by the common people to be injurious to the sight. Hence its vernacular name Mal d'Ojos.

Leaves bipinnate, leaflets oblong, about twelve rows on a side; rachis, and bracts, covered with a coarse brown glandular coating; sepals fringed with hairs and glands, petals erect, stamens very long, red.—*The Gardeners' Chronicle.*

POINCIANA GILLIESII—HALF HARDY SHRUB, YELLOW AND SCARLET.

## THE GIANT REFRACTING TELESCOPES OF AMERICA.

By A. C. RANYARD.

WE live in an age when "records" are almost daily being broken, but it is now almost half a century since the largest telescope yet turned to the heavens was completed by the father of the present Earl of Rosse. He cast his gigantic mirror, six feet in diameter, on the 13th of April, 1842, and after nearly three years' labor it was mounted at Parsonstown in February, 1845. This great telescope, contained in a tube seven feet in diameter, with a focal length of fifty-four feet, still remains the greatest light-grasping instrument which has been turned to the stars; but its defining powers are very inferior to many smaller instruments which have since been made.

It was not till 1846, a year after the completion of the Rosse reflector, that refracting telescopes reached a diameter of fifteen inches. In that year, Merz and Mahler, of Munich, completed two fifteen-inch refractors, one for Harvard College Observatory and the other for Pulkowa. These comparatively small telescopes quickly showed themselves to be superior in defining power to the great Rosse telescope. With the Harvard telescope Prof. W. C. Bond, in 1848, discovered Hyperion, the eighth satellite of Saturn, a discovery which was almost simultaneously made by Mr. Lassell in England, with a reflector of two feet aperture of excellent defining powers. In 1850 Bond also discovered, with the Harvard fifteen-inch refractor, the crape ring of Saturn, a discovery which was likewise very nearly simultaneously made in England by Dawes, with a reflecting telescope of smaller aperture.

For about fifteen years the limit of aperture for refracting telescopes attained by Merz was not exceeded; then America took the lead, and in 1860 Alvan Clark, the father of the present instrument maker, made an eighteen and a half inch refractor, with which he discovered the companion to Sirius. For ten years this

remained the largest refractor in existence; then England took the lead with a twenty-five inch object glass made by Cooke, of York, for Mr. R. S. Newhall, of Gateshead, in 1870. Three years later, Messrs. Alvan Clark & Son made the twenty-six inch refractor for the Washington Observatory, with which the satellites of Mars were discovered. Then followed two thirty-inch refractors, one made by the Brothers Henry, of Paris, for the Nice Observatory, and the other by Messrs. Alvan Clark & Son for the Russian Imperial Observatory at Pulkowa; and, lastly, the thirty-six inch refractor made by Alvan Clark & Son for the Lick Observatory. The optical excellence of the great Lick telescope is vouched for by the work done with it by Mr. Burnham on close double stars, and by the discovery made with it by Mr. Barnard of the fifth satellite of Jupiter.

American astronomers have always shown a preference for refracting telescopes; with the exception of the late Dr. Henry Draper, who figured and mounted for himself a twenty-eight inch silver on glass reflector, no American has constructed a reflecting telescope of any considerable size. Their scientific enthusiasm has restrained them from merely endeavoring to outdo the Earl of Rosse in the construction of instruments of great light-grasping power, and has turned their inventive genius to the difficult problems involved in the evolution and growth of the achromatic telescope. The French still retain the lead as the makers of large disks of optical glasses from which the large refractors are made. The disks of flint glass from which the flint lens of the object glass of the Lick telescope was made took three years to manufacture. It was repeatedly tested and the defective parts were cut out and replaced by fresh optical glass which was welded to the original mass by pressure at a white heat; the disk was then slowly allowed to cool, and again tested, and any new defects found were again operated upon.

The difficulty of manufacturing large homogeneous disks of optical glass is, at present, the chief obstacle in the way of increasing the size of achromatic telescopes. Such large masses of glass are very heavy, and when supported by their edges in a cell their weight causes the lenses to bend; but a small amount of flexure causes less disturbance in the image thrown by a lens than a similar amount of bending of a speculum would cause in the image thrown by a speculum.

For if a reflecting surface is shifted through a small angle the reflected ray is shifted through double the angle, while a similar change in the position of a refracting surface causes only a very slight shift in the direction of the refracted ray. Thus it happens that though lenses can only be supported by their edges, while specula can be supported at their backs as well as at their edges, the small distortions due to the weight of material cause a greater disturbance in the image thrown by a large reflector than in the image thrown by a large refractor; otherwise large reflectors would be vastly superior instruments to large refractors, for with reflectors light of all colors is brought to the same focus, while the difficulty of achromatizing a lens increases with its diameter, and the larger a refractor, the greater must be the ratio of focal length to aperture in order to obtain the same degree of achromatism. Thus the focal length of the Lick telescope is fifty-seven feet ten inches, to an aperture of thirty-six inches, and the Yerkes telescope will have an aperture of forty inches and a focal length of nearly sixty-four feet, or a ratio rather less than one to nineteen, instead of one to twelve, as with small achromatics.

With every increase in focal length all the mechanical difficulties connected with the mounting and the size of dome and shutter increase as the cube of the focal length, for the weight of all the parts increases as the cube of their lineal dimensions. Consequently, every effort is made to keep down the focal length of such large telescopes, so far as it reasonably can be kept down consistently with a sufficient degree of achromatization for defining purposes. An observer who looks through one of these large refracting telescopes for the first time is greatly struck with the amount of outstanding color around the stars. The violet end of the spectrum is generally left outstanding, and the star appears bathed in a field of violet light, which, however, interferes very little with the sharpness of vision.

The great telescope which Mr. Charles T. Yerkes is presenting to the University of Chicago is dwarfed by the size of the Exhibition building, but if the size of the figures standing in the neighborhood is compared with the telescope, it will be seen that it is much larger than the Lick telescope, which at first sight looks larger.

The lenses for the Yerkes telescope are already roughly figured, but they are not finished. Mr. Alvan Clark was present at the last meeting of the Astronomical Society, and gave the fellows an account of the way in which the work is proceeding. I have also received some additional information from Prof. Hale, who is at present in Berlin.

The flint lens is very white. It is a particularly fine piece of glass and weighs about three hundred pounds. Its thickness is about one and a half inches at the center and two and three-quarter inches near the circumference.

The crown lens weighs about two hundred pounds. It is about three inches thick at the center and seven-eighths of an inch at the circumference.

The flint lens corrects the crown, so that the minimum focus will be at about wave length 561.

For photographic work with the spectroscope in the blue, violet and ultra-violet, a small lens will be used near the focus for correcting the chromatic aberration at the center of the field only. Dr. Huggins has used such a lens with his visual objective, and succeeds in bringing the spectrum from F to H satisfactorily to focus. The spectroscope thus remains in its ordinary position, while in the Lick telescope, when the photographic correcting lens is placed over the objective, the focus is changed from fifty-seven feet ten inches to forty-seven feet ten inches, and in practice the spectroscope is not used when the corrector is in place. The principal advantages of the small correcting lens are: (1) small loss of light from absorption; (2) no change in the principal focal plane; (3) convenience in handling; (4) its weight is so small that no change in the balancing of the telescope is necessary on adding the corrector. Its chief disadvantage is that a small lens so near the focus only gives a small field of view, but this is immaterial for stellar spectroscopy.

The telescope, dome and shutter will be moved by electric motors controlled by buttons on a keyboard at the eye end, but the motions can also be directed from the balcony at the head of the telescope, and from a table in the observing room.

Hydraulic rams, which can also be controlled electrically in the same manner, will lift or lower the whole floor of the observatory, so that no observing ladders will be necessary.

The clamps of the telescope are operated by powerful electro-magnets, and it has been found that the instrument can be instantly clamped much more firmly than in a longer period by hand.

The driving clock, which weighs about one and a half tons, is never allowed to run down, but when the weight has descended to a certain point it automatically starts an electro-motor, which winds the clock up again.

All the motions, clamps, etc, can be operated in the ordinary way by hand.

The dome for the Yerkes telescope will be eighty feet in diameter, and the observing shutter will be fifteen feet wide.

The tube for the Yerkes telescope is forty-two inches in diameter at the objective end, fifty-two inches at the center, and thirty-eight inches at the eye end. The sheet steel forming the tube varies from 7·32 inches in thickness at the center to 1·8 inches at the ends. The total weight of the tube is six tons.

The declination axis carrying the tube is of forged steel, twelve inches in diameter, and twelve feet long; its weight being one and a half tons. It runs in segmental bearings in the declination sleeve, which weighs four tons.

The polar axis carrying the whole system is of forged steel, fifteen inches in diameter at the upper bearing and twelve inches at the lower bearing, and weighs three and a half tons.

The great weight of the bearings on these axes is almost wholly relieved and the resistance changed from sliding to rolling friction by means of three bracelets or live rings of steel rolls. One of these encircles the declination axis near the tube, and one is placed above each bearing on the polar axis. These anti-friction live rings are pressed against the axes by means of adjustable springs.

The pier or column is made in five sections. The base section weighs about eighteen tons, the other sections weigh about five and a half tons each. The height of the column, from base to top, is thirty-one feet four inches. Each section of the pier is above six and a half feet high. The head of the pier is of cast iron, in one piece, and weighs five and a half tons. The total weight of the pier and head is about forty-five tons. The height from the base of the pier to the center of motion is forty-three feet six inches, and the total weight of the whole telescope and mounting will be about seventy-five tons.

Mr. Yerkes has purchased about fifty acres of land on the borders of Lake Geneva, Wisconsin, as a site for the new observatory. The plans for the building are now being prepared and its construction will be commenced in the spring. The observatory will be about one hundred and fifty feet above the lake, and at a distance of about seventy five miles from Chicago. Prof. Hale has been appointed director of the observatory, and Mr. Burnham has recently been appointed professor of practical astronomy in the University of Chicago and astronomer in the Yerkes Observatory. No other members of the staff have as yet been appointed. With two such exceptionally able astronomers, one may confidently look forward to many important discoveries being made on the borders of Lake Geneva.—*Knowledge.*

## THE CIPHER CODE.

THE Navy Department has a book which, unlike most government publications, is guarded with great care from the scrutiny of all persons except those who hold close official relations to the Secretary of the Navy. The words, printed in parallel columns, are nothing more than a combination of letters, so arranged that no one but an expert who holds the key can make head or tail of their meaning or even pronounce them. A cursory glance at this book would lead most persons to the belief that it was a dictionary of some unknown language. The book is the cipher code used by the department in communicating with naval officers when they are on foreign stations. It is now not only used exclusively in all messages sent by cable to and from the Secretary of the Navy, but is also used by Secretary Gresham instead of the uncertain and unreliable code of the State Department.

The necessity of the code became manifest some eight years ago, when it was found that the system of cipher messages then in use was imperfect, and could be easily deciphered should any person secure a copy of the key book. To meet the requirements a board was ordered by the department to devise a new code, which should be reliable, and at the same time be so complex as practically to prevent outside parties from arriving at the meaning of the characters even with the book before them. The result was the formulation of the code system now adopted. It is believed that without proper instruction no living mortal could ever arrive at the meaning of the words of a message written in the new cipher. Admiral Stanton a few days ago received a message to proceed with the old Kearsarge to Bluefields, Nicaragua, and two days afterward a message came to the department in cipher saying that no one on board could make out a word of the department's order. This was not due to the complicated nature of the message, but to blunders of the telegraph operators, who are responsible for more trouble in deciphering the messages than are those who write them.

The cipher book contains almost as many words as a school dictionary. They are arranged in columns, and some of the words contain ten letters and some three, but none more or less. Most cable companies charge two words for every one containing more than ten letters, and to avoid this the code is so arranged as to have no word contain more than ten letters. When the Secretary of the Navy wishes to send a message, he first writes it in plain English, or dictates it to a typewriter, who writes each word out with great care and distinctness. It is then given to two officers now at the Navy Department, who are known as the cipher experts. The cipher book is always under lock and key when not in use, and the chief of the Navigation Bureau, who has charge of the movements of all ships, instructions to officers, and the receipt and transmission of cable messages, is responsible for its care and safe keeping. When a message is to be put into cipher, however, no great care is shown to keep the book from the public. At almost any time during the past two months a person going into Commodore Ramsay's office could see two young officers seated at a desk with a message in typewriting before them and on either side two books about the size and thickness of a school atlas. It takes time to put a message into cipher, as great care has to be taken to prevent the misplacing of a single word, which would change the meaning of a sentence and make it extremely difficult, if not impossible, for the officer receiving it to translate it. Even more time is required to translate a message, and when there is a mistake it often takes several hours to put into a readable form a message containing not over one hundred words. Some weeks ago a message came to the department from Admiral Benham which contained forty-two errors. It was impossible to make out its meaning, and it was necessary to send the message back to Rio to be put into cipher again and then forwarded to Washington before the authorities knew what was the matter. The last long message received from Admiral Benham was the one in which he gave an account of the firing on the insurgent ships by the Detroit and the protection given two American coffee ships. This message arrived late at night, and while it was not very long, not containing more than 300 words, two officers were busy making out its meaning from midnight until after 4 o'clock in the morning.

While no officer in the navy is permitted, under pain of court martial, to give away any of the secrets of the code, it is learned that the following is in a measure the way a message is put in code and transmitted: For the words in a message it is desired to send certain corresponding numerals are substituted, and these in turn give place to queer-looking words, specially constructed by the officer in charge of the ship and his aids. These words, which are cabled, are simply arbitrary combinations of syllables, having no meaning or significance, except that they stand for the numerals which represent in the cipher code the words of the proposed message. These words and numerals are contained in a limited number of books, one set of which is kept in the office of the Secretary of the Navy, and one book is given to every ship bound for a foreign station. When an admiral is in command, all communications from the secretary and to him are put in cipher and translated by the admiral's aids, and no other officer is authorized to use the code in the fleet. On board ship the book is kept in a heavy leaden case, water tight, and under lock and key. The case is perforated so that should the vessel be taken, one of the first things to be done is to toss it overboard, where it will at once sink and prevent the enemy from securing possession of a very doubtful means of learning the way we communicate by telegraph with our naval officers. The code proper contains in alphabetical arrangements long lists of phrases that cover every sentence likely to arise with reference to naval matters. It also contains the letters of the alphabet, which it may at any time be necessary to use in spelling out unusual words. A list of numbers is also included, and in parallel columns with the phrases, words, letters, and numbers, are numbers composed of five or six figures. It is by the combination of these figures and letters that words are reached which fit certain sentences, so that should a message be sent to Admiral Benham "to proceed without delay home," the message when in cipher would look something like this: "Aemonite, absodete." Give any one the cipher book, however, and he would look a long while before he could get a phrase that answered these words. It is the combination of the letters that creates the confusion and prevents any one but an expert familiar with the code from arriving at the true meaning. All messages to the Navy Department come addressed to "secnav," which translated means Secretary of the Navy. Frequently, however, the name of the secretary is used, as "Herbert, Washington." One great difficulty in using the code is to give a correct message when a proper name has to be used. A few years ago a message came to the department from Admiral Gherardi, on the Philadelphia at San Domingo, saying that he had sailed for New York at once. As no orders had been given to this effect, the secretary was surprised to receive the message. Upon the arrival of the admiral, however, it was found out that he had stated in the cipher that an officer on board was dangerously ill and could not survive while in the warm climate. He had attempted to use the cipher in transmitting the name, and no one in Washington could make out what it was.

While mistakes frequently occur in sending messages, they are almost invariably due to blunders by the operators in foreign countries. The department experiences more trouble with the messages from South America than from any other part of the world. This is due principally to the great number of relays and repetitions necessary to get the message through and the lack of intelligence of southern operators. In communicating with Brazil, either one of three cable lines can be used. The most expensive is found to be the surest and quickest, but greater time is taken to place the message in the hands of our officers. During the Brazilian revolution several messages have been two days on the way and even longer. The expense entailed upon the department has reached as high as $1,500 for a single message. This message was sent to Admiral Brown during the Chilean war, and contained several hundred words. No discount is allowed the government by the cable lines, and it is at the same expense as other parties in communicating messages. The most expensive message received from Rio cost $500. This came early in January, and has not yet been made public. When the Trenton, Vandalia, and two German war ships were lost during the Samoan hurricane, a message was sent from Auckland which cost nearly $1,000. This was more costly, however, than it would have been had the cipher been used, but owing to the fact that the code book was lost with the vessels, every word was sent in plain English. The saving in messages by the use of the code is about three and one-half words to every word of cipher. A

message such as, "You are directed to proceed to Rio and report to the senior officer present," would be translated in about four cipher words. Including the address and signature, therefore, ordinary messages sent directiug the movements of vessels can be put into from three to ten cipher words.

When the Navy Department gives out to the press cable messages received by the code, the words are so transposed as to be almost in reverse order to the way they came by wire. In no case is the literal translation of the message given, for the reason that, notwithstanding the complicated character of the cipher, the secretary hesitates to furnish, even to the cable companies, a fragment of the key to the code. Should Secretary Herbert decide to make public a message from Aduiral Benham, saying that the Detroit had heen sunk in an engagement with an insurgent vessel, the message would be so thoroughly rearranged that the admiral would probably not recognize it himself again.

The care with which the cipher code is guarded hy naval officers and the necessity for transmitting important naval intelligence in the code were shown during the Chilean trouble. Admiral Brown having discovered an important move on the part of the insurgents and desiring to communicate the fact to Washington, had a cipher message prepared to be forwarded. This message was written out about as follows:

*Secnav, Washington:*

Abridero, ajacito, hiberia, abarloais, laufwerc ebascam. BROWN.

When translated the message informed the secretary that "Admiral Brown reports the landing of 6,000 men at Quinteros Bay, twenty miles north of Valparaiso, and that the government forces were preparing to advance on them." This paraphrase of the message answered every practical purpose, but these curious words would afford little clew to the public had they been given out. In sending his message to the department the admiral was careful to guard against permitting the coutents heing known to the Balmaceda forces, but the carelessness of the officer filing it at the cable office came near causing serious trouble for the United States government. This officer was in the employ of an American newspaper, and after seeing the cipher message off on the wire he filed a message to his paper, which was a translation of the code message in plain English. The Chileau authorities learned that the message had been sent, and accused the admiral of giving information to the insurgents. Secretary Tracy heard of it, and but for strong political influence and the request of the newspaper editor, the officer would have been court martialed.

Both the State and War Departments have cipher codes, hut they are very imperfect in comparison with that of the Navy Department. Throughout the entire Hawaiian correspondence, when instructions were being sent to Minister Willis and when he was answering the numerous questions of Secretary Gresham, the navy code was used exclusively. All of Mr. Willis' messages were put into cipher on the flagship Philadelphia at Honolulu and then sent over on the mail steamers. At San Francisco they were received by the government dispatch agent, who forwarded them over the continent by wire. They were then given to the naval experts for translation. In sending messages to the minister the same method was followed.

It has often heen said that officials of the State and Navy Departments engaged in the work of translating aud decipbering code messages have been bribed to impart important information to foreign governments. One of the most generally helieved of these stories is that at the time of the Virginius affair, when the United States was making demands upon Spain, the Spanish government knew what was going on long hefore the American minister did. Of course, no proof of the charge was ever forthcoming, and the officials all say that it is impossihle that it could be true. Still, stranger things have happened in the government departments at Washington, of which the public has never been informed.—*N. Y. Sun.*

## SHIP RESISTANCE.

UNDER the auspices of the Greenock Philosophical Society, on January 19, Mr. R. E. Froude, of London, delivered the Watt anniversary lecture, his subject heing "Ship Resistance," which was illustrated by diagrams and lime light views. In the course of his lecture, Mr. Froude said that among the many applications of the invention which we are accustomed to associate with the name of Watt, perhaps one of the most conspicuous is the use of steam for marine propulsion; hence ship resistance suggested itself as an appropriate suhject for the lecture. His purpose was to give an outline of the leading principles which enter into the subject, in so far as he himself understood them; those principles which we must in some measure understand and appreciate in order to be ahle to draw correct conclusions from particular facts of experience, or to predict the effect of any novel feature in a ship or uovel characteristic of her form. The most important step to take at the outset is to get rid of the very natural, but nevertheless mistaken notion, that a ship or a fish or other similar body moving through the water experiences resistance mainly and primarily because it has to force the water out of its way. Until thirty or forty years ago the accepted theory of ship resistance, so far as there was any, was based upon this mistaken notion, the resistance being supposed to be due to the inertia of the water so disturbed. According to the now universally accepted theory, in an imperfect fluid such as water a fish or fish torpedo would experience resistance solely in virtue of the frictional imperfection of the fluid, aud the degree of resistance would be (at least broadly speaking and presumably) proportional to the degree in which that frictional quality was present. In the case of a ship moving at the surface, the presence of the free surface, so far from diminishing the resistance, only introduces a new element of resistance, due to the formation of waves. Considering the modern theory as it applied solely to the case of a fish or fish torpedo, and dealing thus with submerged bodies, moving at steady speed, what the lecturer represented was, briefly, that fluid resistance is inseparable from fluid friction; that fluid inertia only comes in as a source of resistance in virtue of and, so far as we have yet seen, broadly speaking, in proportion to the effect of fluid friction; and that in an ideally perfect frictionless fluid there could be no resistance at all, whatever the shape of the body. Then, as to a ship or other body moving at the free and open water space, he first noticed that this wave-making resistance is a distinct and additional source of resistance. The general principle of the action by which a vessel imparts wave motion to the water she moves through, and so experiences resistance, might perhaps be best illustrated by means of the closely analogous action of imparting swinging motion to a pendulum by disturhing its point of suspension. What he called the direct wave-making resistance was the item of wave-making resistance which it is most important to study, not because it is by any means always the largest item, but because it is the only one which is critically or acutely sensitive to speed of ship, and is for that reason responsible for all the complication which attaches to the question of the hest form of ship for given conditions. We may conclude that lowering the level of any element of the displacement of a ship will be most effective to reduce its potency to develop very ohlique wave making, yet, at the same time, up to a certain poiut, will not materially reduce its potency to develop direct wave making. And herein we seem to find the true explanation of the effect which the V bow with fine water line has been found to possess as compared to the V bow with fuller water line, specially to diminish the oblique wave-making resistance. For it is only just at the bow, and in a minor degree at the stern, that the statical wave of a shipshape form presents features conducing to the formation of the very oblique waves of short length crest to crest.

## THE HYDRO-PNEUMATIC EJECTOR.

WE do not remember anything of a more simple nature than See's Patent Hydro-Pneumatic Ejector, which we illustrate in the adjoining diagrams, for hoisting ashes from the stokehold on board a steamer. Referring to these diagrams, Fig. 1 is a side elevation of the apparatus, Fig. 2 is a plau of the same, and Fig. 3 the section of a steamer showing the apparatus fixed in place with the delivery pipe overhoard.

The apparatus consists of a hopper into which the ashes to be thrown overboard are shoveled, and which is placed a little above the boiler room floor, the bottom of the hopper is connected to the ejector, which has suitable connection from a pump and also a discharge pipe leading upward and outward to the side of the vessel above the water line. The hopper is provided with a hinged lid, which makes a water-tight joint upon the same by means of suitable clamping screws. A regulating cock or valve is provided on the pipe from the pump, and a drain cock is situated at the lower portion of the discharge pipe. When at rest the lid of the hopper is kept closed, and the jet cock as well as

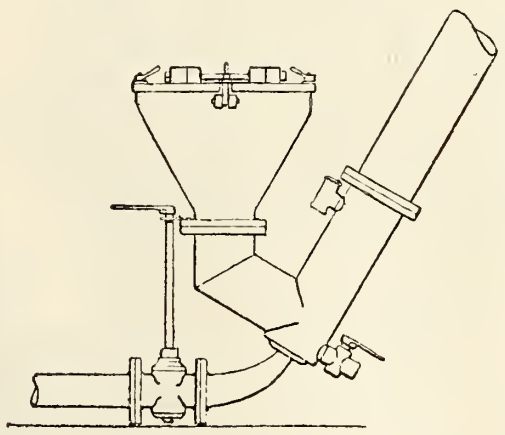


Fig 1

the drain cock are kept shut. When it is desired to work the apparatus, the steam is turned on to the pump. After sufficient water pressure has been obtained in the pump, the jet cock is opened and the lid of the hopper raised.

The only work now to be performed by the firemen is that of shoveling the ashes into the hopper. The ashes in their fall through the hopper encounter the jet of water from the pump, and are forced up and out of the discharge pipe some distance clear of the vessel by the combined action of the dynamic effect of the jet of water and the induced draught of air produced by the same.

After the work is completed the lid of the hopper is closed and secured before the pump is stopped. This, however, is not absolutely necessary, for the reason that if the jet cock is closed very suddenly the whole of the water in the discharge pipe is carried out there-

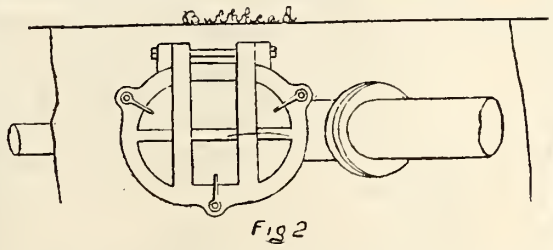


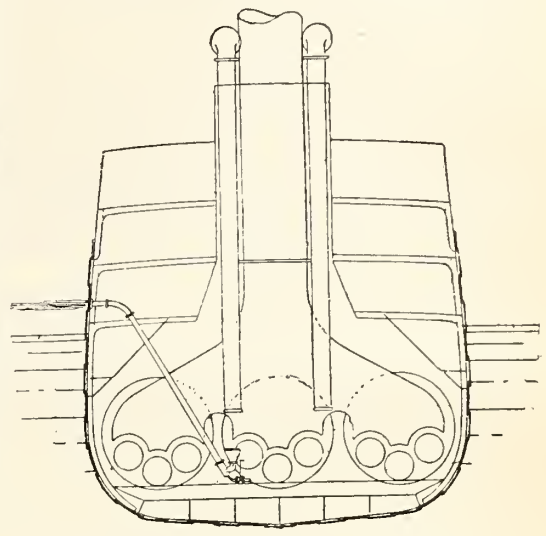
Fig 2

from by its own momentum, leaving the hopper, ejector, and discharge pipe practically empty.

The ashes being thrown out in a liquid condition with great force clear of the vessel, no matter what the state of the weather may be, they will not be deposited on any part of the vessel, either above or below the water line, and thus passengers passing fore and aft will not be soiled or drenched when the ashes are being discharged.

One of the important features which the apparatus possesses is that it takes up little room and can be placed in positions where it would be impossible to introduce apparatus under any of the old methods.

It prevents one of the fruittul causes of trouble between firemen and sailors, and obviates the necessity of calling the watch to assist in removing the ashes, and on whatever ship it is used it saves the firemen one of the hardest and most wearisome of their duties.



THE HYDRO-PNEUMATIC EJECTOR.

It has been placed upon a great many steamships, and its use is attended with marked success in every case.—*Marine Engineer.*

## AMERICAN MEN FOR THE NAVY.

PRESENT conditions in the Hawaiian Islands and in Brazil must incline citizens most conservative as to our foreign policy to feel that the United States Navy ought to be strengthened.

New men-of-war should he built after the best designs by competent naval constructors. They should be officered by able men, guarded by well-drilled and equipped marines and manned by a crew less heterogeneous and more American than that to be found on some of the vessels now in service.

F. M. Bennett, passed assistant engineer in our navy, in a recent valuable and suggestive article in the *United Service*, states that the Enterprise sailed frou New York in 1887, with a crew, exclusive of officers and marines, numbering 138. Of these only 73 were native-born Americans. This is a much better showing than that made by the ill-fated Ashuelot, when she went down in the China Sea eleven years ago. Among her 111 men, exclusive of marines, twenty nationalities were represented and only 19 men were natives of the United States.

Mr. Bennett has taken pains to collect statistics like these, and in his article on "American Men for the Navy" shows good grounds for change in the service and the basis upon which a change may be made.

He says: The *materiel* of our navy has completely changed in recent years, and, with only a few exceptions, our new ships have decided national characteristics; they are not only American in design and construction, hut they carry with them that peculiar something in style and appearance that distinguishes them in foreign ports from the warships of all other countries, just as the Yankee dash and swing distinguishes the American abroad from the Frenchman, the Russian, or the Englishman. Rare specimens of the American naval officer, it is true, seek to disguise their nativity by the cultivation of a transatlantic accent; but there appears no good reason why the whole service should follow suit by disguising our national vessels with foreign-tongued crews. Our ships, engines, and guns are thoroughly American, and it is high time that the crews were Americanized by so modifying present naval practices as to make life on a man-of-war possible and even attractive for our citizens. Theories must be laid aside and some practical method put in operation wherehy an American youth can find in the navy of his country an opportunity for a career at least equal to that open to him in trade or in the mechanic arts.

To Americanize the service and make it sufficiently attractive for our native-born citizens to take it up as their career in life several propositions must be enacted into laws and put in operation; chief among which may be cited the following:

1. The possihility of enlisted men becoming commissioned officers.
2. An increase in the number of warrant officers, and restricting appointments to this class to the petty officers of the navy.
3. Increased responsibility and dignity of position conferred upon petty officers on board ship.
4. A retired list, or civil employment on shore, for enlisted men after long and faithful service.
5. More attention given to the comfort of enlisted men in the design of ships and in the administrative details of life on board them.

Regarding the first proposal, we would do well to adopt either the French or the English system of advancing warrant officers, previously described, preferably the French system. The details of this system when put in operation would involve certain restrictions as to age, length of service, conduct record, etc., and promotion would depend upon passing a professional examination. As is the case in France, opportunity should be given candidates to fit themselves for the theoretical part of the examination by the establishment of a preparatory school at the Naval Academy or at one of the navy yards.

A certain proportion of the vacancies occurring in the rank of ensign each year should be regarded as belonging to this class of candidates, and the examination of warrant officers should be held earlier in the year than July 1, in order that graduates of the academy could be assigned to such of these vacancies as remained unfilled after the successful warrant officer candidates had been commissioned.

In connection with this subject of advancing warrant officers to commissioned rank, consideration for the engineering force should not be lost sight of by allowing it to be overshadowed by the larger and more prominent seaman class. A grade of warrant-officer-machinist should be created for the artificer branch of the service, into which enlisted machinists could be advanced under rules and regulations similar to those practiced in advancing petty officers of the seaman class to the dignity of warrants.

These warranted machinists should be on an absolute equality with the other warrant officers in regard to pay, quarters, uniform, etc., and equally with them should they have the privilege of competing for commissions in their own corps. The number of such warranted machinists could be established by making it bear the same ratio to the number of commissioned engineers that the number of seamen warrant officers bears to the number of commissioned line officers, and the number of them entitled to commissions annually should bear a similar ratio to the number of line warrant officers advanced to ensigns.

The number of warrant officers in our navy compared with the number of commissioned officers is proportionately much less than in some of the other well-organized navies, and by increasing the number by advancing worthy petty officers we would not only be increasing the inducements for enlisted service, but would be following the example of successful naval organizations as well.

It cannot be denied that many of the duties now falling upon commissioned officers could be performed as well, if not better, by warrant officers, whose training has been practical rather than theoretical, and this being the case, it would be in the interest of efficiency as well as economy to gradually replace many of the commissioned officers now in the service by the less ornamental but more useful warrant officer.

The matter of the comfort of the men, and sometimes of the officers, on board ship is not given sufficient consideration by the designers. Of course a war ship *must* fulfill several important conditions as to speed, coal endurance, weight of battery, etc., but the comfort of the men who have to handle and fight the ship, a matter that directly affects the efficiency of the whole fabric, is too often made subordinate to everything else, or is even not considered at all. Officers familiar with ship life know that a crew that is comfortably messed and berthed is a good crew, and that one in which the men have to swing two or three deep and to "wolf" their food out of tin pans on the deck is an uncomfortable, discontented, and poor one, which no amount of drill and training can make really efficient.

A few words as to the proper source of supply of seamen for our new navy will not now be out of place. There is a popular belief throughout the country that men who dwell along the sea coasts constitute the only element fit for service in the navy, a belief that was essentially correct so long as sails were the motive power of war ships, but is now sadly out of date. Although sails have now passed away for naval purposes, there is still a powerful faction in the navy that clings to this old idea, and by giving it publicity serves to discourage the very element that we most need from entering the service.

Only a few months ago it was stated in a letter published in this magazine that the proper element to draw upon for sailors to man ships in case of war "is found among fishermen and stevedores." It is high time that this idea is exploded; fishermen and stevedores may have been excellent material for men-of-war's men in the days of sailing frigates, but that day is now done. The man on shipboard now, whatever his rating may be, who can weld the broken ends of an iron bar is infinitely more useful to the ship than is the man who can splice a rope. In dealing with this same subject of seamen for a modern navy, that eminent French authority, the late M. Gabriel Charmes, wrote as follows:

"Even if born on a sailing ship, a native of the coast would not any the more be fitted for handling the engines than any ordinary conscript. The complicated engines on board a modern vessel would puzzle him quite as much; he would be just as awkward and just as difficult to teach. To have breathed the sea air from his earliest youth would avail him nothing. Long cruises, interminable voyages which could only be endured by those accustomed from youth upward to live between sea and sky, have given place to a new style of navigation exacting more intelligence than strength or perseverance. In this way the best seamen are as often secured by conscription as by maritime inscription, or rather a great many more are secured by the former than by the latter. The townsman makes a better gunner than the fisherman does, and is still better if he happen to be a workman or a mechanic."

When it is understood by the public that the mill men of Pittsburg and Birmingham or the engine builders of Detroit and Milwaukee are wanted in the navy in preference to the fishermen of New Bedford and Marblehead, we may hope to get men who will not be entirely fish out of water in the complicated compartments of a modern war vessel and who, under the direction of a gun captain who is a machinist rather than a sailor, will not ruin the fine mechanism of a gun mount by scrubbing it with sand and canvas "to make it shine." No disrespect is meant in these remarks to the seafaring class of our citizens, which class under a different order of things for a long period maintained the honor of our flag at sea. Such communities as that of Marblehead, for instance, which brave little town once contained six hundred widows as a result of the American revolution, and furnished almost all the men of the frigate Constitution during her glorious career in the war of 1812, may well rest on their laurels and accept the truth that the service has so changed as to need a different order of men to-day than they can supply.

F. M. Bennett,
Passed Assistant Engineer U.S.N., Member of the Society of Sons of the American Revolution.

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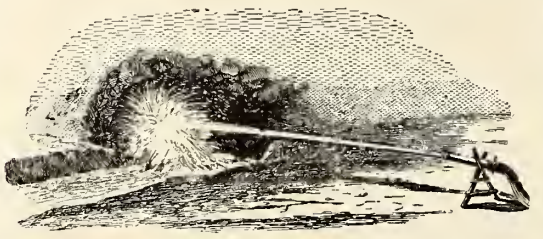
Cotton cloth was first made in India, and was in use there as early as 2,343 years ago. About the year 450 B.C., Herodotus spoke of this textile fabric, made from the trees of India which bore, as their fruit, fleeces surpassing in beauty and delicacy those of the sheep.

## HYDRAULIC MINING.*

*Water-Distributing and Gravel-Washing Apparatus.*—While the dam and the ditch with its appurtenances are being constructed, the gravel-washing and the gold-saving implements and apparatus should be gotten on the ground and put in place, the point where they are to be located being immediately under and in close proximity to the lower end of the ditch. At its lower extremity the ditch empties itself into a section of flume, at the end of which is situated the bulkhead or pressure box, a large oblong receptacle, built of strong planks and so called because the head or pressure of the water is here measured.

Connected with or located immediately above this structure is the sand box, a square compartment sunk several feet below the floor of the flume, the design of this box being to catch any sand or fine gravel coming down the ditch, such material, when it reaches this point, falling into the sink, being the depressed portion of the box, and is there retained. Through a gate at the side of the box this stuff is discharged as often as its accumulation makes it necessary. If much sand is allowed to enter the sand pipe, it tends to impair the efficiency of its action.

The pressure box, with a width of about six feet, varies in length from ten to thirty feet, a greater length being required when it has two feed pipes to supply, also where the sand box forms a part of it. For the sand box a wooden apron is placed in the bulkhead and so arranged that it catches the sand and drops it



GIANT PLAYING ON CAVED BANK.

into a chamber below, which is supplied with a discharge gate. A gate is set at the upper end of the pressure box to prevent any floating stuff entering it. There should be water enough in this box to cover the supply pipe to a depth of several feet, that no air, or as little as possible, be carried into it, to which end this box is usually divided into two compartments, the water being brought into a placid state in the upper before it enters the lower one. That the water supply and exhaust be kept in equilibrium as near as may be, a waste gate should be placed in the flume above.

The main supply pipe starting from the bulkhead should descend to the washing pit with as few deflections, rises or depressions as possible, as these not only tend to retard the passage of the water through the pipe, but also promote the collection of air within it, rendering an explosion imminent. To obviate this at all times, and to guard against it when filling the pipe, at which time it is much increased, air valves are to be placed at suitable intervals along it. All large water pipes should be equipped with a sufficient number of air valves, these escapes being provided with brass floats, as the wooden ones are apt to swell, and becoming wedged in the valves, the pressure of the air without is insufficient to press them down. When the bank down which the pipe has to be carried has much inclination it should be placed on a stout framework, and, besides being braced on both sides, should be heavily weighted with bowlders as a security against any movement, which, should it occur, might cause much inconvenience and possibly serious damage.

* This article was prepared by the late Dr. De Groot for the Eleventh Report of the State Mineralogist, just issued; but its publication with that of much other valuable matter was prevented by the necessity of revision and omission, so that the volume might be reduced to reasonable limits. It covers familiar ground, but is, on the whole, a complete and careful review of the industry and hydraulic mining methods. The article has been furnished to *The Mining and Scientific Press* by State Mineralogist J. J. Crawford.

This pipe for several joints at its upper end is much enlarged to insure a more free admission of water. Below that point it is all the way of uniform size, or as far down as the junction of the branch pipes, if any there are. In early times the letting on and shutting off of water was effected with a wooden gate, raised and lowered by means of a lever. For this crude and clumsy contrivance there has now been substituted in all large works the heavy cast-iron gate operated by a screw, powerful and easily manipulated. Everywhere now, on the dams, ditches and reservoirs and in the washing pits, these improved structures are in use, differing but little, except in size, and in this according to the service required of them.

A powerful machine of this kind is employed for admitting and shutting off water at the entrance of the main feed pipe. In the performance of this task care should be taken to let on the water gradually, as too great a rush might carry in so much air as to cause a disaster, this being a precaution to be always observed under similar circumstances.

The size of the feed pipe depends on the quantity of water to be transmitted through it, a pipe 22 inches in diameter being sufficient to pass anywhere from 1,500 to 2,000 miner's inches. When the quantity of water ranges from 3,000 to 4,000 inches a 30 inch pipe should be chosen, the friction caused by the passage of the water being less, comparatively, in large than in small pipes. The iron used in the construction of these pipes varies from No. 16 to No. 11 and lower, according to the pressure to which they are to be subjected. For a 22 inch pipe No. 16 iron is usually employed for pressure up to 150 feet; No. 14 from 150 to 200 feet, and No. 12 from 200 to 300 feet, the latter being about as great a head as the water is apt to be used under in hydraulic washing. For a 30 inch pipe No. 14 iron has been found to answer for pressure up to 150 feet, and No. 12 from 150 to 275 feet.

Before being placed in position these and all other iron pipes to be used in connection with hydraulic mining should be immersed in liquid asphalt, such as is now being manufactured for this and similar purposes. Coal tar, with which these pipes were formerly coated, is now giving place to the asphalt preparation, it having been found equally cheap and more efficacious.

Formerly the lower end of the feed pipe was connected with what was known as the distributer, a short cast iron box firmly anchored in the washing pit, the duty of which was to receive the water brought in by the feed pipe and distribute it to the several smaller pipes that lead to the giants or monitors, the number of these pipes corresponding with that of the machines to be supplied with water. Being ponderous, costly and liable to burst, the distributer has come to be pretty generally discarded, the plan of connecting all distributing pipes directly with the main feeder, as now practiced, having superseded it.

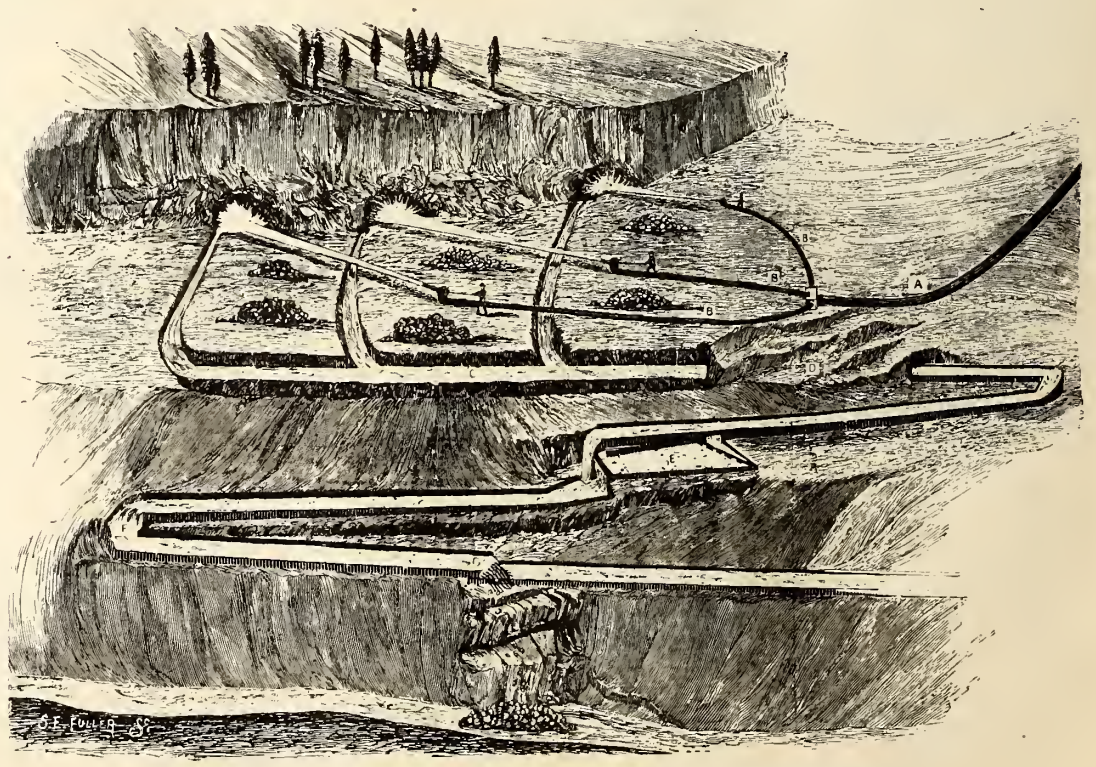
The accompanying plate presents a general view of a portion of the gravel-washing and the gold-saving appliances located in and below the washing pit.

To that part of the hydraulic apparatus connected with the final discharge of the water through nozzles, various names have been applied, such as the "goose neck," "globe monitor," "dictator," "deflector," "knuckle joint," "little giant," etc.

While certain of these names are suggestive of some property, feature or other peculiarity of the machine, more of them would seem to have no special significance; although for each of these devices the inventor has claimed some peculiar merit, and not always without reason, only a few of the entire number are now much in use.

For the information of those not posted in these matters it should be explained that, in miner's parlance, the terms monitor, nozzle and giant mean all the same thing, they being applied to these several machines indifferently, and in the case of the nozzle, very improperly, as this is only an appendage of the apparatus, being only the projecting tube or nose through which the water makes its final escape. There is need for a specific name for these discharge pipes, which should designate and be confined to that portion of them by which these movements are directed and controlled, and thus the present confusion be avoided.

These pipes range from four to nine inches inside




HYDRAULIC MINING—GENERAL VIEW, SHOWING THE PLANT.

A, main pipe conducting water from bulkhead to distributer; B B B, distributers; C, sluice; D, rim-rock tunnel; E, undercurrent; F, drop; G, grizzly.

diameter, the quantity of water they are capable of discharging varying from 300 to 1,500 miners' inches of water, according to size, pressure, etc. They can throw an effective stream on a gravel bank 200 feet away. Frequently as many as four, and even five, of the largest sized machines are played in a single pit at the same time, each machine discharging from 1,500 to 1,700 cubic feet of water per minute. Notwithstanding the force of one of these large jets of water, so indurated or so tenacious are some portions of the gravel to be washed that it has to be shattered with powder preparatory to playing the water upon it. The force of a large stream of water as it issues from one of these nozzles is hardly less than that of a cannon ball at the instant of its discharge. When operated the machine is brought as near the bank as is compatible with the safety of the pipe man, in order that the full effect of the jet may be obtained. When the bank is very high, fatal accidents sometimes occur through its sudden caving. When much over a hundred feet in height, the bank is piped off in benches as a safeguard against accident caused by these caves. The manner of piping off a cave is shown in the figure.

When it is said that a full set of the largest of these machines, as we sometimes see them operating in the hydraulic mines, is capable of performing the work of a thousand men, the remark is to be understood in a literal sense.

## NONSUCH PALACE.*

OF all the suburban palaces of our English sovereigns none has left behind it such a reputation for luxury and magnificence as Nonsuch. Leland says of it:

"Hanc quia non habent similem laudare Britanni
Sæpe solent nullique parem cognomine dicunt."

"Unrivaled in design, the Britons tell
The wondrous praises of this nonpareil."

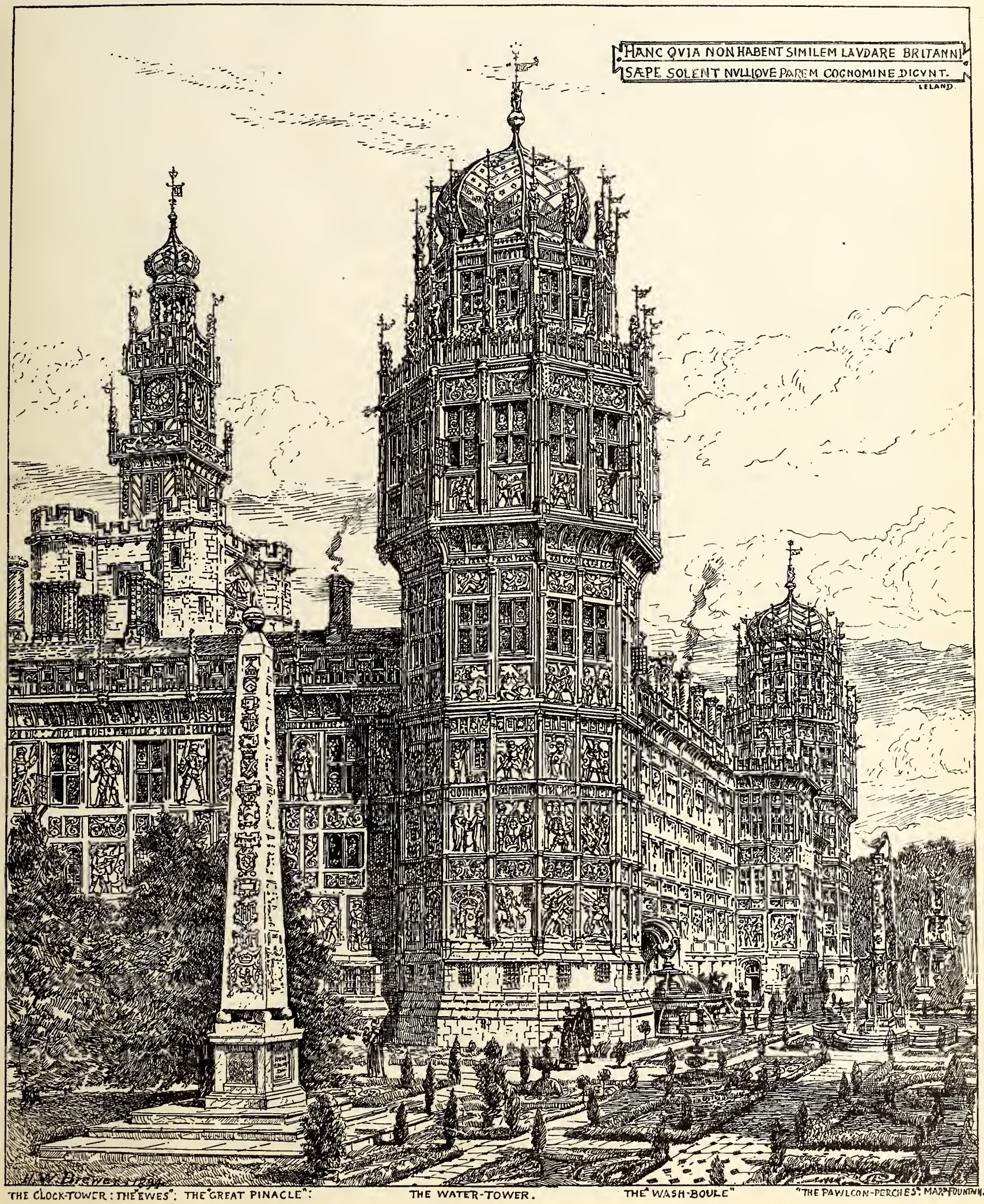
Not one stone of this splendid palace now exists, and its very site can only with difficulty be traced; but fortunately we have two fairly good old views of it.

* From the *Builder*, London.

The first is an engraving by Hofnagle, dated 1582, and published in George Brown's "Urbium Præcipuarum mundi Theatrum," and the other is a much smaller, but I think more valuable engraving by Jodoc Hondius, dated 1610, in "Speede's Surrey." Both of these views represent a kind of elevation of the garden front of the house, with the outer court, in rather singular perspective, showing over it. Hofnagle's view only shows the upper part of the building, the lower portions and the interesting gardens being concealed by a high garden wall; but in Hondius' view this wall is omitted, so as to show the whole building and the garden with its very curious fountains and other structures.

Both of these views are more or less impossible and purely conventional in treatment; but with the help of the various descriptions remaining of the building, more especially the survey made by Cromwell's commissions in 1650, one is able to realize what this royal palace was like in its palmy days.

As Nonsuch was only commenced in the eighteenth


HANC QVIA NON HABENT SIMILEM LAVDARE BRITANNI
SÆPE SOLENT NVLLIQVE PAREM COGNOMINE DICVNT.
LELAND.
THE CLOCK-TOWER: THE "EWES": THE "GREAT PINACLE":
THE WATER-TOWER.
THE "WASH-BOULE"
"THE PAWLCON-PERCHES": MAS. FOUNTN.

NONSUCH PALACE—A RESTORATION BY MR. H. W. BREWER.—*From the Builder.*

year of the reign of Henry VIII. (1527), and was totally destroyed by order of the Commonwealth in 1650, it cannot, of course, have taken a very important position as a historical edifice.

Henry VIII. does not seem to have completed it, as it was purchased in an unfinished condition by the Earl of Arundel in Queen Mary's days. Henry, Earl of Arundel, is said to have spared no expense in completing the house and gardens. It seems to have passed again into the hands of the crown in Elizabeth's time.

The palace seems, somehow or another, to have passed into the hands of Lord Lumley, son-in-law to Lord Henry Arundel, but it was again sold to the crown in 1591. The last royal person who inhabited it was Henrietta Maria, Queen of Charles I. In the survey taken by the commissioners in 1650 it is described as "late percell of the possessions and joynture lands of Henrietta Maria the relict, and late wife, of Charles Stuart, King of England."

Nonsuch Palace was situated near Cheam, in a village called Cuddington, which village, together with its church and manor house, would appear to have been destroyed to make way for the palace with its park and gardens.

The buildings surrounded two courtyards. The outer or lower court measured internally 150 ft. by 132 ft., and the inner or upper court was 137 ft. by 116 ft. The "outer court" was upon a lower level than the "inner court," and there was a rise of eight steps from one to the other. Between the two stood a gate constructed of freestone three stories high, with embattled turrets at the angles, and crowned by a lead-covered tower to hold the clock, which clock and tower are said to have been "of most excellent workmanship and a special ornament to Nonsuch." There was a little court to the east which contained the kitchens and other offices. The larger or outer court was two stories high, embattled, and constructed entirely of freestone. It contained the lodgings of the almoner, chamberlain and other attendants upon the queen, and also the buttery, wine cellar, etc.

And now comes a singular fact: although the lower or outer court, which was only inhabited by court officials and servants, was constructed entirely of freestone, the portion of the edifice containing the royal and state apartments, the "upper court," was built of wood, except the basement; or perhaps, to speak more correctly, it was framed in wood, no doubt "post and pan" work. It would, however, appear that the wood was not visible outside, because we are informed that this part of the building was "battled" (embattled) with frames of wood covered with lead and supported with strong bars of iron, "which battlements are a great grace and a special ornament to the building." The two great towers at the southeast and southwest angles of the building were also embattled with lead, and their lanterns were covered with the same material. The southwest tower (that shown in the foreground of our drawing) was the water tower. It contained a vast cistern of lead "of so singular a use that pipes being branched from thence supply the offices and the whole house with water." In fact, water was regularly laid on as in a modern house. It would be interesting to know whether this was the first house in England with a regular water service.

The whole of the walls of the upper building, except the basement, were covered with a series of bass-reliefs in plaster representing figures and various scenes. It has been stated that these were composed of "rye dough."* Now, although rye dough may have entered into the composition, as it does into that of some modern kinds of stucco, yet, of course, it would not be sufficiently hard or white for the purpose alone. The German black bread does certainly get hard when stale, but if you soak it in water for a month or two it can be eaten in soup, but we never heard of its being used for building. There is, however, a passage in Leland quoted by Lysons which seems to offer some solution of the difficulty. Leland says that at Cuddington, where the king (Henry VIII.) was building, "is a vaine of fine yerth, to make moldes for goldesmithies and casters of metale, that a loade of it sold for a croune of golde. Like yerth to this is not found in all Englande." Now, may not this "yerth," when mixed with the rye dough, have formed a fine hard plaster or stucco, in which these figures were either modeled or cast?

The gardens of Nonsuch Palace seem to have been as remarkable as the building itself. The principal garden appears to have surrounded the three external sides of the inner court, and probably from the fact that the private chambers of the king and queen overlooked it was called the "Privy Garden." The survey informs us that there was "a large garden called Privye Garden" lying round and adjoining into the three outsides of the inward court building—inclosed by a brick wall 14 ft. high, cut out and divided into alleys, quarters and rounds, set about with thorn hedges. "In the said garden there is one piramede or spired pinacle of stone," and near which, against the west turret, is placed one "large marble 'wash-boule,' over which stands a marble pelican fed with a pipe of lead, to convey water into the same. There are also two other marble pinacles or piramedes called the 'Powlcon perches' (falcon perches), between which a fountain of white marble with a lead cistern, which fountain is set round with six trees called *leylack trees*, which trees bear no fruite, but only a very pleasant flower." There are also "in the said privey garden one hundred and forty fruit trees, two ewe trees, and one juniper tree," etc.

These fountains and the large stone pinnacle are all shown in the view by Jodoc Hondius. Probably the account given by Hetzner, who visited the place in Elizabeth's time, is not much exaggerated; he says that it was built "with an excess of magnificence and elegance even to ostentation; one would imagine everything that architecture can perform to have been employed in this one work; there are everywhere so many statues that seem to breathe, so many miracles of consummate art, so many casts that rival even the perfection of Roman antiquity, that it may well claim and justify its name of Nonsuch, being without an equal, or, as the poet sings:

> This which no equal has in art or fame,
> Britons deservedly do Nonsuch name."

H. W. B.

* Lysons' Environs of London, p. 111, note 58. Second edition.

[From the Builder.]

## WESTMINSTER ABBEY.*

It is an impossible task to attempt to describe the monastic buildings fully. It may suffice to say that at the dissolution of the monastery the buildings were subdivided to form houses for the canons. No systematic rebuilding has ever taken place, but changes for individual convenience have constantly taken place, sometimes to reveal a curious feature of old work, sometimes to cover it over for centuries; and alas! sometimes to destroy it. The little cloisters open from the confessor's work by a wide passage, the two arches to carry the walls overhead being ancient, and the barrel vault of recent date. The arches inclosing the cloister garth are of brick, probably the work of Wren, the wrought iron gate being of passable design. The walls of the inclosure are of fourteenth-century date, built, to a certain extent, of very small stones, in which may be noted some freestone with signs of former use, notably the shaft of an early column next to Mr. Cheadle's door. At the south end of the west walk an early Norman window has recently been laid open. Its purpose was apparently to ventilate the sewer referred to. Above it is a curious piece of ancient construction. The ashlar work is arranged in squares laid diagonally, and between a course similarly laid, worked in dark stone.

These cloisters occupy part of the site of the infirmary, which opened into the infirmary chapel, which was dedicated to St. Catharine. Perhaps even the nave and aisles formed the infirmary either wholly or in part, the chancel being screened off as the chapel. The outlines of the walls and the bases of the shafts, hidden more or less by modern brickwork, alone remain. They were cleared to the extent seen a few years ago. They are of late Norman date.

The Jerusalem chamber and adjacent buildings formed the abbot's house, some of these being now included in the deanery. The former chamber contains an admirable Elizabethan chimney piece, and in the large window are some roundels of Norman stained glass inserted. The long table in what was formerly the abbot's hall is said to have been made out of some of the wreck of the Spanish Armada.

Some of the curious Elizabethan paneling in the neighboring rooms would be all the better if it were cleared of its many coats of paint.

The present entrance to the cloisters on the west formerly led into the conversation parlor, and over it, very probably, was the guest chamber, or one of the guest chambers and its chapel.

The materials of the abbey demand a passing note. The walls of the confessor's work show a large amount of Caen stone, ashlar, and dressings, as we have already seen, backed up with rubble, the walls being of great thickness and solidity. The later works have walling of Kentish rag, variously squared and laid, the bulk of the dressings being of Reigate or similar freestone, backed up with rubble, doubtless derived from the former buildings as far as it would go, the whole mass standing, not upon a feeble foundation, as is so usual in ancient churches, but upon a solid mass of concrete and rubble of considerable but varying depth.

This mode of construction was all the more necessary, since much of the subsoil is very loose sand; a good foundation when subject to compression, but which is liable to flow in a stream when dug through. Much of the confessor's work was doubtless broken up to form this mass. The floor level, after so many years of the rise of the external ground, is still in good proportion to it, indicating that it must have been once well above the present ground line.

A few blocks of unknown stones are occasionally met with, but the names of most can be determined. It may be worthy of remark that much of the work of the latter part of the fourteenth century is of Roche Abbey stone. A good deal of the cloisters is formed of it. It was used again in Abbot Islip's work. A single block of Quarr Abbey stone has recently been found high up in the walling by Mr. Wright. It had formed part of some Roman building, for red mortar still adheres to it.

Some few of the mediæval bases had plinths of Portland stone, although the use of this material in London is supposed to date only from the seventeenth century; most of the later works of that century and since were done with Portland stone. The recent ones have varied, Chilmark stone being now used for the present works of refacing in progress on the south side.

From the crossing eastward to the chapel of Henry VII., the abbey is a vast storehouse of mediæval monuments, exhibiting some of the choicest specimens of workmanship in stone and metal, sadly desecrated, it is true, and despoiled of the many jewels that once added so much luster to the shrine of the confessor and its surroundings, but still a magnificent series. Besides these are a very large number of monuments of the Renaissance period, very stately, and often highly enriched with decorative work and heraldry, but their erection against the outer walls of the chapels entailed the removal of the delicate mouldings and carving of the arcarding, and, however much we may admire the beauty of some of the monuments themselves, it cannot but be regretted that greater respect was not shown to the mediæval work.

The confessor's shrine and the royal tombs immediately surrounding it form a valuable series of monumental examples from the time of Henry III. to Henry V., including mosaic work, metal work, alabaster and stone carving in great variety. The mosaic has been much destroyed, both on the shrine and the tomb of Henry III., but enough remains on the twisted columns of the former, and on the north side of the latter, to give an idea of the once gorgeous effect of these two examples, the earliest of the series. In strange contrast is the perfectly plain tomb of Edward I., without carving or effigy, situated immediately westward of Henry III.'s monument in the northwest angle of the Saints' chapel. This monument is the only one remaining without decorative treatment, each of the others having some special point of interest. Queen Eleanor's beautiful monument, now much defaced, with brass effigy and elaborate wrought iron grille, remarkable as being of English workmanship; the tomb of Queen Philippa (1369), with its elaborate canopy work in alabaster, remaining on its south side facing the ambulatory, and the larger one over the head of the recumbent effigy; Edward III.'s monument, a late fourteenth-century tomb, having a wooden canopy, and a brass effigy, inscription, and mourners on the south face; and, finally, the much defaced monument of Richard II. and his queen, the canopy over painted with a representation of the crowning of the Virgin.

The tomb of Henry V. has fared worse than the others, and the rough wooden effigy has lost its covering of silver. The wrought iron gates are noticeable, and the elaborate canopy and figure work of the chantry itself; the altar was that of the Annunciation.

In the floor of the Saints' Chapel, immediately below the back of the altar screen, is some of the "Opus Alexandrinum" and a brass of John of Waltham. East of the shrine is a slab with inlay of red and white mosaic, and a marginal inscription in Lombardic characters.

The beauty of the royal monuments is, perhaps, excelled by that of the tombs north of the sanctuary—all of the decorated period—commemorating Aveline of Lancaster (1273), daughter of William de Fortibus, Earl of Albemarle, and married to Edmund Crouchback, Earl of Lancaster, whose monument is the most easterly of the three. He died in 1296. The third tomb, that of Aymer de Valence (1323), is thus slightly later than the Crouchback, and of smaller dimensions on account of the space already taken up by Aveline's tomb. All three are covered with detail and foliage of the most exquisite kind, and a row of mourners on the ambulatory or north side deserves careful study. The spandrels of Aveline's tomb are particularly beautiful. The monuments in the chapels surrounding the Saints' chapel, and forming the *chevet* round the apse, are of great variety and interest. They cover a period from the thirteenth century to the late Renaissance, and in one or two instances bringing examples of monumental work down to our own day. Marble work, mosaic, enameled metal, and carving and effigies in marbles and alabaster are all represented. The first chapel on the north side is that known as Abbot Islip's, with a loft over containing the wax effigies which were carried in front of the coffin at the funeral of those represented. The front of the chantry toward the ambulatory is a perpendicular design of two stories, the lower portion pierced and admitting of a view of the chapel proper. The upper part is tabernacle work, forming a screen to the upper story, the string dividing the two being ornamented with Islip's name and rebus. His initials and a rebus are also on the wall over the entrance to the Chapel of St. Erasmus, which virtually forms a vestibule to the first of the octagonal chapels, that dedicated to St. John the Baptist. Three tombs with effigies of no particular merit in themselves divide the chapel from the ambulatory, and commemorate Bishops Colchester, Reithall, and George Fascet, Abbot of Westminster, 1498–1500. This latter has a stone canopy over it, and in the cornice moulding is one of those excellent examples of a decorative monogram in which the mediæval carver excelled. Against the north wall, standing in front of the arcade, is a small arcaded tomb, with little ornament but a delicate series of caps and trefoiled arches, said to be to the memory of Hugh and Mary de Bohun, *c.* 1300, children of Humphrey de Bohun, Earl of Hereford. In the center of the chapel, taking up a large amount of its floor space, is the monument of Thomas, Earl of Exeter, who died 1622–23, a very large altar tomb in black and white marble with effigies of the earl and his first wife. The marginal inscription is a good example of simple lettering, boldly designed, and round the tomb are several shields of arms.

The Hunsden monument, against the eastern wall of this chapel, is the most gorgeous and the largest of the Renaissance monuments in the Abbey. It reaches to the level of the springing of the chapel windows, and is a marvel of workmanship in marble and alabaster, and among its decorations are a series of shields showing the family connections, fine examples of heraldic carving. The early wall arcading in this chapel, where not destroyed by the insertion of the monuments, is worthy of notice, also the vaulted vestibule known as the chapel of St. Erasmus. Next in order is the chapel of St. Paul, interesting chiefly for the fine altar tomb of Sir Gyles Daubenay and his wife (1507 and 1500 respectively), who was Lord Chamberlain to Henry VII. The altar tomb is of Purbeck, the effigies of alabaster, elaborately colored. Round the tomb are a series of shields with the arms of the family and their connections, the whole being inclosed within a wrought iron railing of excellent design, with standards at the angles, ornamented with the Daubenay badges. Altogether this is one of the best and most perfect specimens of its date remaining in the Abbey.

Forming part of the screen between the chapel and ambulatory is a Bourchier tomb with banners supported by a lion and an eagle, good specimens of mediæval heraldic carving, and deserving to be carefully drawn before they become more decayed. The other monuments in this chapel are of the Renaissance period, and are not such as to call for any special mention.

The two corresponding chapels on the south side of the ambulatory contain a larger portion of early to late monuments. The chapel of St. Edmund is particularly rich. Here are the effigies of William de Valence, of wood incased in metal, with the well-known enameled shield charged with the Valence arms. The figure rests on a wooden tomb, in its turn carried by a stone base with the arms of the family and of England. On the opposite side of the doorway into the chapel from the ambulatory is the tomb of John of Eltham, a beautifully modeled effigy in alabaster, the sides of the tomb retaining a large number of the "mourners," little statuettes, in this case excellent examples of the costume of the period. Close by this latter tomb are the children of Edward III., a small tomb, with the effigies recumbent on it, of William of Windsor and Blanche de la Tour.

In the center of the chapel on low tombs are three magnificent brasses, that of Eleanor de Bohun (1399) being by far the finest and the most perfect of those remaining in the Abbey. The workmanship of the brass effigy, canopy and shields is of the highest order. Adjoining this is another large brass commemorating Archbishop Robert de Waldeby (1397), also represented under a canopy. The third is to Sir Humphrey Bourchier, killed at the battle of Barnet, with a good example of mantlings and beaume. Behind this in the

* Continued from Supplement, No. 948, p. 15145.

wall is a tomb of Sir Bernard Brocas, having a recumbent effigy under a canopy. The tomb of Frances, Duchess of Suffolk (1559), is a marble altar tomb with recumbent effigy, notable for its heraldic work.

The remaining chapel—that of St. Nicholas—has a good stone perpendicular screen dividing it from the ambulatory. The principal monuments of interest are a Renaissance tomb of Villiers, Duke of Buckingham, in black and white marble, occupying the center of the chapel; a perpendicular canopied monument for Bishop Sutton, and a brass of Sir Humphrey Stanley with three shields and an effigy near the entrance. On a tomb above this is a delicate fragment of carving, supposed to have formed part of a reredos to the altar which formerly existed where the monument of Lady Fane now is.

Passing up the steps to the chapel of Henry VII., the fine altar tomb of that monarch and his queen, standing in the center of the apse, is the chief object of interest. It was the work of Torregiano, and is said to have cost £1,500. The effigies are of bronze, gilt, the tomb on which they rest being of black marble, with a delicate frieze of alabaster and brass ornaments. Inclosing it is a magnificent screen of bronze, once ornamented with figure work, and exhibiting the familiar badges of Henry VII. in its panels.

Eastward, in the small chapel at the end, is the slab covering the spot of Cromwell's burial, but his body no longer rests there, having been removed two years after interment. A modern monument to the late Dean Stanley is interesting as a memorial of the present time, and for the excellent likeness of the recumbent effigy.

The chief monuments of interest in the aisles are those of Queen Elizabeth on the north and of Mary Queen of Scots on the south, well-known monuments, with good Renaissance detail and effigies.

The small chapel of St. Benedict, leading out of the south transept and in a corresponding position to that of Abbot Islip on the wall, has a large number of monuments, of which that of the Earl and Countess of Middlesex (1645), and the earlier altar tomb, with effigy, of Abbot Langham, are the best.

It will be unnecessary to enter into a detailed description of the numberless mouuments in the transepts. That of Chaucer in the south transept (of Purbeck marble), and of Sir Francis Vere and of Lord Norris in the north transept (two elaborate Renaissance examples), are the most noteworthy.

The north transept, known as the "Statesman's Aisle," is crowded with a very large number of monuments that are not, perhaps, conspicuous by their beauty, but which, nevertheless, form part of the history of the Abbey. The south transept is fully explained by its name of "Poets' Corner." The west wall, next the muniment room, is known as the "Historical Side."

The nave is likewise full of monuments chiefly mural, their design being in most cases of no particular interest. One of the most recent, however, that of the late Mr. Fawcett, by Mr. Alfred Gilbert, R.A. (placed here in 1887 to the late postmaster-general), is deserving of notice as one of the most successful and original in conception of modern monuments in the Abbey, or anywhere else in this country. It is on the south wall of the southwest tower.

The aisle arcading of the nave was ornamented with armorial shields of the benefactors to the Abbey during its construction. Of these, sixteen westward of the crossing were carved and painted. Four have disappeared, but those remaining are excellent examples of heraldry. The others, partially obliterated, were painted in the spandrels of the arcading, and are later in date.

Under recesses in the south walk of the cloisters are monuments of early abbots, but the names on the stones above them are of modern date, and probably incorrect. On one is a low relief effigy with pastoral staff.

The Abbey is not rich in ancient glass. The oldest portion is in the triforium of the presbytery, and consists of fragments of *grisaille* of early fourteenth century date. In the east window of Henry VII.'s chapel is a figure of the founder, and in the chapels and aisles of the same are many old quarries with initials "K. H." crowned, and badges—the portcullis, fleur de lis, etc.

The three windows of the apse were made up in 1753, with a mixture of old and new glass. The later date was found among the pieces of the new work. There are some fragments also in the windows at the west end of the aisle. The glass in the great rose window is of the eighteenth century; that in the south dates from 1814. The modern glass in the Abbey is poor in the extreme.

To sum up the architectural estimate of Westminster Abbey as whole, it may be said without fear of contradiction that its great glory lies in its interior, and that, in addition to the quality of unusual height already mentioned, great part of its effect is due in the first instance to the erection of all the more important portion of the eastern end in one style, and that the style in which Gothic architecture was at its best—when it had gained great picturesqueness and freedom while still retaining a certain reticence in ornament and a noble purity of architectural lines; and secondly, to the architectural good sense shown by the builders of the later portion of the nave in carrying on the building on the same lines as the eastern portion, with only the unobtrusive differences which arise from variations in the mouldings and some smaller details, and which are not sufficient to destroy the unity of the whole design. Had the nave been completed with that frank adoption of the style of a century later, without any regard to harmonizing it with existing work, which was usual with mediæval builders, the effect of the interior would have been by no means so striking and impressive as it now is. Externally, there is much to interfere with our enjoyment; indeed it might perhaps be said that there are few English churches of the same size and importance which impress us so little externally. The most effective view is from the southwest angle of the cloister; not adopted in the view drawn by Mr. Begg, because it is only after all a very partial view. On the north side the greater part of the exterior has been restored, as one may say, to the bone, and for the most part badly restored; the only exception being Mr. Pearson's north transept, which is one of the most remarkable examples of the revival of the mediæval spirit in modern times that could be found; and though we are averse to imitative restoration in general, there can be no doubt that the transept as it was before Mr. Pearson took it in hand was in a miserable state, and had lost almost everything of original value, and we do not quite know what better could have been done with it than has been done. The want of a central feature of some kind over the crossing is much felt; it might still be possible to supply this by a lantern of light construction. It is obvious from the design of the crossing piers that the building was not intended to have a tower at the crossing; probably this was due to the French influence under which it was erected. The upper portion of the western towers is another defect of the building, which has received praise far beyond its deserts. There is no doubt that the towers, whether designed by Wren or Hawksmoor, are admirably proportioned to the rest of the structure, and in that respect show the eye of a true architect, and when one is at a distance and cannot see the detail they pass well enough. But in detail they are wretched, and if they serve to show that their classic designer made a praiseworthy effort at Gothic detail, they also prove that he had no perception of or feeling for its true character. For our own part, we should be very glad to see them down and replaced with terminations of the same general outline and more in keeping with the style of the substructure; not necessarily an imitation of mediæval work, but something more in keeping with it. At the opposite end of the building is the only portion which, in its own style, is equally fine and perfect internally and externally, and which moreover has the interest of being peculiarly and specially English. It is not certainly in the highest style of Gothic architecture, and a severe criticism may well find fault with the busy over-elaboration of detail on every part, but it is a work carried out in every part with the highest artistic enthusiasm and striving after perfection; and it is rather a curious comment on what has been said as to the peculiarly French influence recognizable in other portions of the interior of Westminster Abbey, that a French art critic who visited England for the first time a little while since told us that he had seen nothing in all London which delighted him so much as Henry VII.'s chapel.

COLORS OF THE IMAGES OBTAINED BY THE APPLICATION OF VARIOUS ORGANIC COMPOUNDS.

| Reagent employed. | Color of image obtained. | Color of image obtained by acidifying developer with hydrochloric acid. | Color of image obtained by adding ammonia to the developer. |
|---|---|---|---|
| Aniline and its salts..... | Green. (Whites discolored.) | Green. (Cleaner whites.) | Blue violet. |
| Paratoluidine ..... | Red. Soluble in water. (Print weakens by washing.) | None. | Pale yellow. |
| Orthotoluidine..... | Green. | None. | Violet. Slightly soluble. |
| $\beta$ Naphtholamine hydrochlorate ..... | Black. | Brownish black. | Reddish. |
| Para-amidophenol hydrochlorate or sulphate... | Brown. ("Photographic" tone.) | Reddish brown. | Deep violet. |
| Benzidine hydrochlorate | Deep blue. | Yellowish brown, becoming blue on washing. | Faint yellow, becoming blue on washing. |
| Toluidine hydrochlorate. | Deep blue. | Reddish yellow. Soluble. | Pale yellow. |
| Guaiacol ... ..... | Orange. | None. | Feeble gray. |
| Pyrogallic acid ..... | Violet black. (Print becomes veiled.) | Pale yellow. | Deep reddish violet. |
| Eikonogen..... ..... | Greenish. | Brown. | None. |

## PRINTING WITH MANGANESE SALTS.*

By R. CHILD BAYLEY.

I WOULD explain at the outset that this short account of the experiments recently performed by Messrs. Lumiere upon a printing process based upon the employment of salts of manganense, consists of a translation of two communications sent by them to the society elaborating two former papers on the subject, abstracts of which have already been published in the *Photographic Journal*, vol. xvi., p. 254, vol. xvii., pp. 55, 83, and 182, followed by a demonstration of the way in which I have been experimentally working the process lately.

The process, for which an English patent, No. 5,892, 1892, has been taken out by them, is roughly as follows:

Potassium permanganate is treated with an organic acid (preferably lactic), the first result of which is the formation of a copious black precipitate. By continuing the addition of the acid, the precipitate is re-dissolved, and a brown liquid results. To this liquid, which they believe to be a solution of manganic lactate, glucose, sodium sulphite, or some other reducing agent is added. Upon its surface paper coated with gelatine is floated, which, when dry, will be found to be sensitive to light.

The paper has a brown color, and upon exposure to sunlight gradually becomes white. Prints so obtained can be more or less "developed" by the application of one of a considerable number of organic substances, which upon coming in contact with the unaltered manganic salt give rise to a coloration, the tint of which depends upon the so-called developing substance and the condition of its application. The subjoined table mentions some substances which they have employed with their reactions, but I have not thought it necessary to give the entire list, as set forth by Messrs. Lumiere, because some of the substances named therein give practically no results. The reactions of more than one of these different substances can be combined so as to obtain an image of a color bearing a certain resemblance to those given by each of the reagents when employed alone, it being a necessary condition, of course, that the mixed compounds shall not react upon one another.

As regards the stability of the image to be obtained by the process, since these images are composed of products resulting from the oxidation of any of a large number of organic compounds, their permanence varies with the substance employed. For example, we are told that prints developed with salts of aniline are extremely fleeting, while, on the other hand, when paraamidophenol hydrochlorate is employed, they appear to be remarkably permanent. I pass round a card upon which slips developed with the compounds named thereon are mounted. The card has been exposed to the action of light, air, and moisture out of doors since October 28. The moisture has been so great that the slips have come off the card, and have been remounted (that it has been excessive you will easily see by the condition of the card), yet where the light has acted is not visibly different from the parts which were covered, except in one instance—obtained with para-amidophenol, where the color has gone a little darker. I regret that they are not half-tone prints so exposed, but I had none by me at the time.

With a view to ascertaining whether the finished print contained manganese or not, a solution of paraamidophenol hydrochlorate was made by Lumiere to react upon one of manganic lactate, a brown and but slightly soluble precipitate resulting. This precipitate was washed and analyzed, and found to contain no manganese whatever.

When the spectrum was projected upon paper sensitized with manganic oxalate, the greatest reduction was found to take place between the rays D and E, while, if the exposure be long enough, it will be found to be sensitive to the entire luminous part of the spectrum. A curve showing its sensitiveness coincides very nearly with one showing the luminous intensity, the former being slightly displaced toward the side of the more refrangible rays.

All these substances I have not tried. Those which have answered best in my hands have been aniline and orthotoluidine sulphates, prints by both of which I pass around, together with some by MM. Lumiere—as to the developers employed to produce which I can only guess. The deep blue prints are developed with orthotoluidine sulphate with a little hydrochloric acid, which seems to keep the whites cleaner; the violet prints are merely the blue ones subsequently treated with ammonia; the greens have been obtained by the use of aniline sulphate with hydrochloric acid; the red with orthotoluidine (base) and ammonia dissolved in a mixture of alcohol and water. The formula published by MM. Lumiere does not involve the use of either glucose or sodium sulphite as an aid to increased sensitiveness, but potassium formate is used for the purpose. I might mention that I have tried all three of these, the glucose and the formate with satisfactory results, but have failed entirely with sodium sulphite. This last has, in every case, reduced the manganic salt immediately upon its addition, without exposure to light.

To prepare the sensitizing solution, 100 grains of potassium permanganate are covered with two ounces of water, and, in small quantities at a time, 4½ drachms of the strongest lactic acid are added. (These are MM. Lumiere's published proportions translated into English weights and measures.) The reaction is accompanied by effervescence, and unless the flask containing the mixture be cooled in a current of cold water, and the acid added very gradually, the mixture will heat, boil over, and be lost. It should be complete in about two hours, when the result is a brown oily solution, smelling strongly of the lactic acid. From 40 to 50 grains of potassium formate, or a similar quantity of glucose (this latter must first be dissolved in the smallest quantity of water), can then be added, well mixed up, and the liquid filtered. The solution thus obtained can be applied to gelatinized paper, either by floating, brushing, or in any other way that might suggest itself to a photographer, the excess blotted off, and the paper dried in the dark. I pass round some pieces of paper sensitized a day or two ago. The solution appears to keep fairly for some days, at any rate; there is a slight crystallization sometimes.

Printing must be done under a positive, and it is said by MM. Lumiere to be, if the paper has been properly prepared, as fast as with albumenized paper. All I can say is that my paper evidently has never been properly prepared; it has certainly never been anything like as sensitive as this. Printing is complete when the very highest lights are quite white, and development can then take place. The paper must not be washed, but plunged at once into the developer, or the latter must be quickly brushed over its surface, when the print rapidly gains in brilliancy and vigor. All that is then necessary to complete is to wash out all the soluble salts it contains, which would probably be effected in about half an hour.

The vigor of the print seems to depend on three, and sometimes four, things:

1. The vigor of the transparency from which it is made.
2. The amount of lactate in, or rather on, the paper.
3. The strength of the solutions employed to develop, and the substances therein.
4. In the case of some the coloring matter is more or less soluble, and the print is weakened by prolonged washing.

I have not been successful with rough papers, and the reason seems to be this: The action being a bleaching one, the light, even in the high lights, does not penetrate into the body of the paper sufficiently to alter the whole of the sensitive salt; consequently, when the developer is applied, there is a discoloration,

* A communication to the Photographic Society.

and the print looks muddy. This is also the case if the sensitizing solution has been allowed to soak through the gelatine into the body of the paper, as has been the case in some of the prints passed round.

## A NEW AIR PYROMETER.

This recently patented continuous pyrometer, by Uehling & Steinbart, is based on the law of the flow of air through small apertures. When a pipe is closed at two places by partitions of thin plates through both of which a small hole is pierced, and when one end of the pipe is connected with a vacuum of a constant tension and the other end open to the atmosphere, then air is sucked by the vacuum through the apertures, causing a partial vacuum in the space between the two partitions, and a barometer connected with it shows very soon a constant tension. The same quantity of air passes through both apertures, but the volume varies according to the difference in pressure between the atmosphere and the air in the space between the two partitions; a larger volume passes through the second aperture than through the first. The proportion between the volumes passing the apertures is constant for equal temperatures; it is changed, however, as soon as the pipe is heated at either one or the other of the apertures, because the air expands by heating. According to this the barometer will show less tension, as the air is heated while passing through the first aperture, and greater tension when the temperature is increased at the second aperture, and this change in tension is used to measure the heat.*

The space between the two small apertures can be connected to different barometers at different places, *e. g.*, at the furnace and in the offices, which latter may be at a considerable distance from the furnace. The accompanying diagram shows a pyrometer built for furnace No. 2 of the Sloss Iron and Steel Company, Birmingham, Ala.

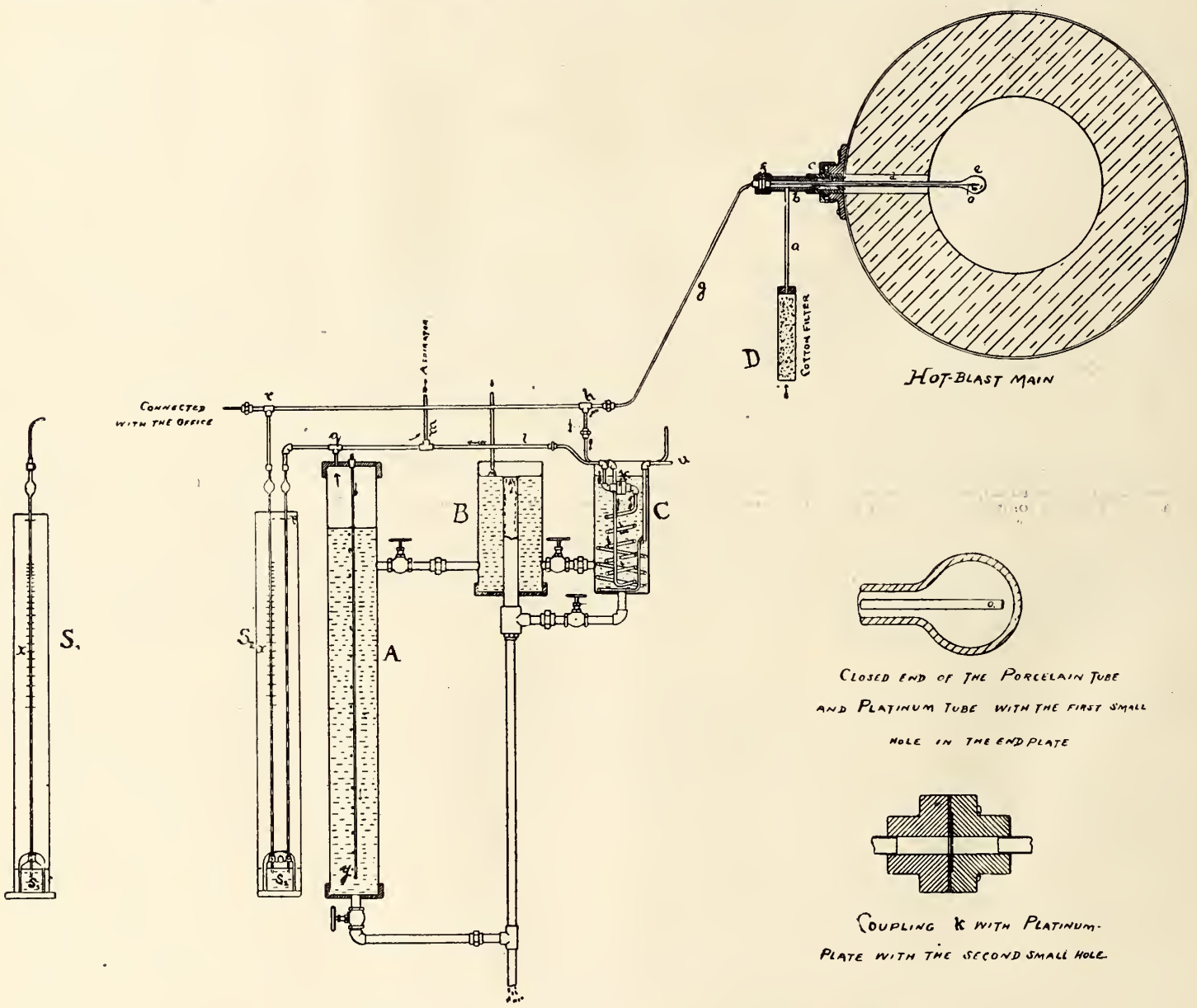
An aspirator, not shown in the cut, working by water or steam power, which is connected with the cylinder, A, by the pipe, *m*, forms the partial vacuum or suction of constant tension. The aspirator sucks always more air away than is furnished by the pyrometer. But the deficiency is supplied by the regulator, A. This regulator has only two openings; one of them is connected with the aspirator, the other is continued by a tube dipping into water to a depth of 4 feet. A valve serves to regulate the height of the water in the cylinder. As soon as the water column in the barometer tube connected to the cylinder by the T connection, *q*, rises to the height of 4 feet, the air bubbles up from the end of the tube, *y*, through the water furnishing the surplus of the air sucked away by the aspirator.

Thus the column in the barometer tube remains constant at *p*, viz., 4 feet over the level of the liquid in the Wolfs bottle $S_2$. Cylinder C is filled with water which is kept boiling hot by the outer of the two coils placed in it, which is connected either to the boilers or the hot blast at *u*. The vessel, B, serves to keep the water in C always on the same level and to regulate the water level in A.

The constant partial vacuum produced in the pipe, 1, by the aspirator and the regulator, A, draws the air out of a pipe connection, which opens at the cotton filter, D, to the atmosphere. The air which is sucked in here is purified of its dust by the cotton and passes through *a* and *b*, through the porcelain tube, *d*, which is connected to *b* by the stuffing box, *c*, into the bulb, *e*, of the porcelain tube, *d*. As this bulb is inside of the hot blast main and has the same temperature as the blast, the air is heated to this temperature when it enters the platinum tube, *o*, which lies inside of the porcelain tube.

The platinum tube is closed at this end and into the end plate a very small hole is bored through which the air has to pass into the tube. The air passes back from there through the platinum pipe, *o*, the copper pipe, *g*, through the inner coil, *i i*, in the vessel, C, in which the water is kept constant, at the boiling point. Then the air passes the second small hole in the platinum plate, which is inserted into the coupling, K, and is sucked away from there through the pipe, *l* and *m*, to the aspirator. The two small apertures are shown on a larger scale at the right side on the accompanying sketch. The two barometers, $S_1$ and $S_2$, are connected with the space between the two apertures by the T connection at *h*. One of these, $S_2$, is placed near the furnace for observation by the stove man, the other, $S_1$, is placed in the office of the superintendent and is connected with the pyrometer at *r* by a copper pipe of small inside diameter.

The distance from the furnace in this case is about 325'. By this scale the reports of the stove man can be easily controlled.




THE UEHLING & STEINBART PYROMETER.

## RECENT PROGRESS IN THE MANUFACTURE OF STEEL CASTINGS.

This was the title of a paper read at the recent meeting of the American Society of Mechanical Engineers. The author, Mr. H. L. Gantt, pointed out at the start the great difference in the product of the present day as to quality when compared with that of earlier times. The Midvale Steel Company made the first soft steel castings in the United States in 1886–1887, which were subjected to a ballistic test. Steel castings had, however, been successfully made in this country in 1867 (this date was given by Mr. Edwin H. Cramp). That year the William Butcher works made some crossing frogs of crucible steel. Castings of that day were very much honeycombed, since the use of silicon for solidifying was unknown.

In April, 1876, two small hammer dies were made, and in May a hammer head weighing 2,535 lb. Little improvement in the method was made for some time, although the quality of the steel was better. The Midvale Company then made a great step by omitting the ground pots out of the moulding mixture and washing the mould with finely ground fireclay. This mixture clung so closely to the castings that only comparatively simple shapes could be made with certainty. The next step was to use a mixture of silica sand and flour. In large castings, however, the tendency of the flour to burn, and thus leave the sand without a proper bond, proved an objection. By mixing silica sand with molasses and thoroughly grinding it, a suitable mould was obtained. In 1887 the Midvale Company made the first gun carriage of steel castings. These castings frequently had blowholes. This was obviated after a time by the use of hot metal. The author admitted that shrinkage holes and cracks still occurred; but since the steel castings had been cooled

* Supposing the law of Gay Lussac to be exact for air under different pressures, the decrease of tension for every degree of heat could be calculated as follows:

Let $b_0$ = the pressure of the atmosphere,
$b_1$ = the tension between the two plates,
$b_2$ = the tension of the suction,
$\alpha$ = the coefficient of expansion of air,
$\sigma_1$ = the specific gravity of the air entering the first aperture,
$\sigma_2$ = the specific gravity of the air entering the second aperture,
$t$ = the difference in temperature between the first and second apertures, and the heat of the air entering the second aperture = 0, then the velocity of air passing the first hole is:

$$V_1^2 = 2g\frac{b_0-b_1}{\sigma_1}$$

and of the air passing the second hole,

$$V_2^2 = 2g\frac{b_1-b_2}{\sigma_2}$$

because the same quantity of air passes both apertures, the air being under the pressure $b_0$ and the temperature $t$ at the first hole, and under the pressure $b_1$ and the temperature 0 at the second hole, the velocity at the second hole $V_2$ when both holes have the same area must be

$$V_2 = V_1\frac{b_0}{b_1}\frac{1}{1+t\alpha}$$

Substituting the values of $V_1$ and $V_2$ we have

$$\sqrt{2g\frac{b_1-b_2}{\sigma_2}} = \sqrt{2g\frac{b_0-b_1}{\sigma_1}}\;\frac{b_0}{b_1(1+t\alpha)}$$

The specific gravity $\sigma_2$ is according to the change in pressure and heat:

$$\sigma_2 = \sigma_1\frac{b_1(1+t\alpha)}{b_0};$$

substituting, we have

$$\sqrt{2g\frac{(b_1-b_2)\,b_0}{\sigma_1\,b_1\,(1+t\alpha)}} = \sqrt{2g\frac{b_0-b_1}{\sigma_1}}\cdot\frac{b_0}{b_1(1+\alpha t)}$$

consequently

$$b_1-b_2 = \frac{(b_0-b_1)\,b_0}{b_1(1+\alpha t)} \text{ and } b_1 =$$

$$-\tfrac{1}{2}\left(\frac{b_0}{1+\alpha t}-b_2\right) \pm \sqrt{\frac{b_0^2}{1+\alpha t}+\frac{1}{4}\left(\frac{b_0}{1+\alpha t}-b_2\right)^2}$$

Although this formula is not exactly right, it shows very well the working principle of the pyrometer. The formula indicates that the divisions become very gradually smaller and smaller as the temperature rises, but for a suction of 48 inches of water it still shows a difference of about one inch for 100° F. at a temperature between 1,200° and 1,500°, if water is used in the barometer.

Further information may be had from Alfred Steinbart, care of the Sloss Steel and Iron Company, Birmingham, Ala.

from the bottom up they are less frequent, for the founder fixes on the heaviest portion for his sink head, which is usually 20 per cent. of the total weight; this must remain fluid till the whole of the casting proper is solid.

By making a steel casting as nearly as possible of uniform thickness it has been possible to make castings 20 ft. long and 10 ft. wide. The author then proceeded to show the reason why it was easier to make more satisfactory castings when they were to be large than when a small one was required, and we may quote him in conclusion:

"Most steel castings are made by the open-hearth process, and the furnace usually melts from 5 tons to 20 tons. To pour even 5 tons of steel into castings averaging 100 lb. in weight would, as a rule, take so long that those poured last would be of inferior quality on account of the cooling of the metal. As a rule, a large portion of the heat is poured into a comparatively few large castings, and the remainder put into the smaller ones. If the metal is very hot to start with, this may give fair results, but in all cases the least desirable metal is put into the small castings.

"This difficulty seems almost insurmountable by the open-hearth process, but is readily overcome by a small Bessemer converter, from which we can get two or three tons of metal as hot as we may wish it. Add to this the fact that we can get from the converter that quantity of metal of any composition we may desire, every half-hour throughout the day, and we realize the advantage of the Bessemer process for making small and medium weight castings. The manufacturers of electric motors who have been buying their castings from open-hearth foundries have apparently not realized what the Bessemer foundry has in store for them. It seems hard to believe that perfectly solid steel castings can be made of the following composition with regularity: Carbon, 0·12 per cent.; manganese, 0·3 per cent.; silicon, 0·3 per cent.; but it is a fact. It may be noted, however, that this steel, while very well adapted to electrical purposes, is of but little value for any miscellaneous castings, except very small ones, on account of the tendency it shows to crack during the process of solidifying when cast in shapes at all complicated.

"The fact that we can make a number of different kinds of steel each day if we use a converter, and but two or three heats at most in twenty-four hours if we use an open-hearth furnace, gives a great advantage to the founder using the converter, especially if he is making all kinds of steel castings, enabling him, as a rule, to make far more prompt deliveries than is possible for the open-hearth founder doing the same variety of work.

"Among the other advances made in casting steel may be mentioned one for making a casting having one or more facings of a steel much harder than the body of the casting. The process consists in lining such faces of the mould as will be adjacent to the parts of the casting it is desired to harden with a metallic alloy in a crushed or powdered state, capable of being melted and absorbed by the molten steel in contact with it, and of such a nature as to impart to the steel a hard face, or a face of such a composition as may be readily hardened. If it is desired that the casting shall have a permanently hard face and be used for stamp shoes, crusher jaws, hammer dies, etc., ferro-manganese gives the best results. If it is desired to do machine work on the face and make it extremely hard afterward, ferro-chrome is most suitable. The fact that it is possible to produce a soft steel casting, having a face that can be hardened without causing the remainder of the casting to become brittle, will undoubtedly make it possible to use steel castings in place of chilled iron in many places with great advantage."

## MALACCA TIN.

PICTURES of many strange and out-of-the-way places have from time to time appeared in the *Daily Graphic*, but I cannot remember having seen any views from, or remarks upon, the Malay Peninsula. And yet in this large tract of country, now in process of being developed, live many Englishmen, whose lives of isolation are passed in content because of their engrossing task of civilizing and opening up countries formerly the scene of barbarism and disorder. Most people have heard of the large native states, Perak and Selangor, and owing to the frequent visits to England of the Maharajah of Johore, the name of that independent state is also a familiar word, though possibly it might puzzle many who have met its agreeable ruler to exactly locate his kingdom on a map.

By degrees the states of Perak and Selangor have, under British protection, worked their way upward, and there are others which, though not yet emerged from the chrysalis stage, patiently endeavor to follow in the footprints of their more matured neighbors. Of these is the tiny state of Jelebu, which some six years ago was accorded British protection at the request of the people, who wearied of internal dissensions and raids from their powerful neighbors of Pahang. The state was consequently placed under a collector and magistrate, one of the officers of the Resident of Sungei Ujong, and thus became amalgamated with that government. The policy followed in the older states has been adopted, and the English officer in charge lives alone among the people, and by gradual process accustoms them to the ways and methods of English rule.

As can be readily imagined, the life of this sole local representative of authority is not a monotonous one.

AN IRRIGATION WHEEL, MALACCA.

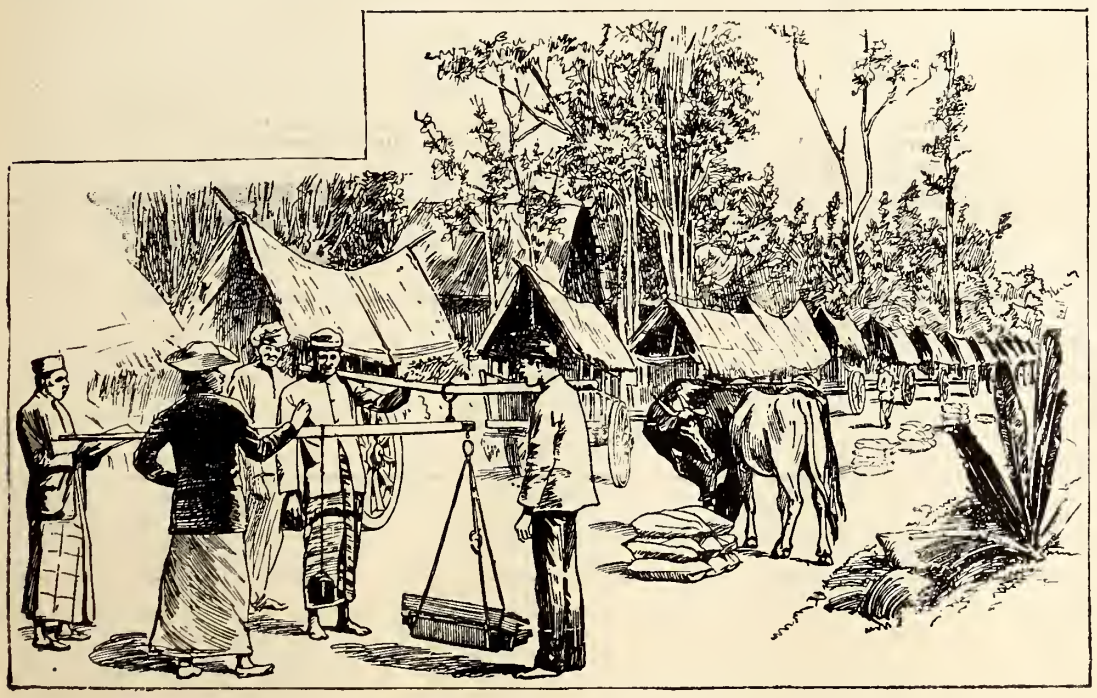
His work embraces a vast variety of interests, from exploration to education, and from the laying out of townships to the dispensing of justice, together with innumerable other duties. Were the state not under British protection, the Chinese would soon become the chief power in the country, gradually but surely ousting the idle and improvident yet delightful Malays. A Malay is almost always a gentleman, and therefore needs no further description.

The wealth of this state, as in the larger ones, consists of its tin mines, and to work these the Chinese flock thither. That these mines are being worked to some purpose is proved by the fact that in 1886, the first year of British protection, the revenue was less than $2,000, whereas it is now nearly $200,000.

One of the sketches shows the tin ore, which some people may not know has the appearance of black sand, packed in bags and being weighed at the customs office previously to export by bullock cart. Sometimes, as may be seen, the ore is smelted at the mines and exported in slabs.

Another sketch represents an irrigation water wheel, one of the cleverest things ever devised by an untaught people. This wheel, which is constructed of bamboos, is sent round by the current of the river, the water is picked up by the revolving cylinders and poured into a wooden trough at a higher level—the level of the banks—and by this means it is sent forth into the adjacent fields. Many an engineer whose wanderings have brought him so far afield has stood astonished at the sight of a contrivance so simple and so ingenious.

The scenery of this country is beautiful. The climate, though perhaps occasionally warm, is agreeable, and is moreover, for Europeans, one of the healthiest in the world. Game of all sorts abounds here, and it is a matter for wonder that in these days of travel, only a few hours' journey from Singapore, there should still remain for discovery a country of possibilities as yet unknown to the most enterprising trotters round the globe.—*Daily Graphic, London.*



MALACCA—WEIGHING TIN AT THE CUSTOM HOUSE.

## ENAMEL PAINTS.

THE manufacture of enamel paints has grown to very large proportions during the past few years, the great bulk being manufactured for use by amateur painters and artists, although a very large quantity is consumed by painters for surfaces where a very high polish is required. Enamel paints, says the *Chemical Trade Journal*, are paints which, when applied to the surface of objects, leave behind a hard and very lustrous coating, very different in appearance to the much duller coat left by an ordinary paint, and therefore have a greater decorative effect. What were known as varnish paints have been common for years, but these were only used for low-class work, and not for any artistic work at all. There is no doubt but what the greatly extended use of cycles during the past decade, and the need of the owners for some paint which would dry with an enamel surface, has done much to promote the use of enamel paints.

A great variety of enamel paints can be made. They may be made so as to be cheap or dear, quick or slow drying, according to circumstances; but, however they may be made, they must possess one characteristic, viz., that of drying with a luster and with a hard surface.

This condition can only be attained by using some resin, like copal, kauri, resin, etc., such bodies being the only ones which possess sufficient luster and are capable of ready conversion into a soluble or liquid form, so that they can be spread by a brush over the surface of the object to be painted. The nature of the solvents which are used to dissolve these resins will depend upon the nature of the resin used, and also upon the character of the paint which is to be made. If it is to be a quick drier, some volatile solvent must be used; while if a slow-drying enamel is wanted, a different kind of solvent is used. Simply to dissolve the resin in the solvent is, however, not sufficient, for then only a varnish is obtained, whereas a paint is required; the difference between the two kinds of materials being that, although both leave a lustrous surface, a varnish dries with a transparent coat, underneath which the real surface of the object is visible, while a paint dries with an opaque coat, which hides the real surface of the object. To enable a paint then to do this, it must contain in addition to the resin and the solvent an opaque substance which is generally colored, which opaque body is known as the pigment. The pigment to which the color of the paint is due must have one property, that of insolubility in the solvent which is used in making the paint, or otherwise it will lose its opacity, and nothing but a colored varnish will result. Hence it is that although a large number of colored bodies are known, yet, owing to their property of solubility in solvents, they cannot be used for coloring enamel paints.

### THE SELECTION OF PIGMENTS.

The best pigments to use are the mineral colors, lamp or vegetable blacks for black enamels, using a little spirit soluble aniline black when enamels are made with methylated spirit to give them a pleasant tone. Vermilion, red oxide, Indian red, and Derby red make good red pigments, vermilion and Derby red having, however, this defect, that, being heavy, they have an unfortunate tendency to settle to the bottom of the paint pot. Vermilionettes, royal reds and other red pigments made from orange lead and the eosines, do not work very well in a methylated spirit paint, owing to the solubility of the coloring matter in the spirit, still they are largely used when a bright and cheap red color is wanted. Brunswick green, emerald green, and the green lakes made from the anilines do very well for green enamels. The chrome yellows and oranges cannot be excelled for yellow and orange enamels. Brown enamels are best made from umber. White enamels are made with either lithopone, Orr's white, blanc fixe, gypsum or zinc white. White lead is unsuitable.

When quick-drying enamel paints are required, then solvents of the nature of methylated spirit, resin spirit, shale naphtha, or turpentine must be used. Shale spirits and resin spirits make the cheapest paints, while those made from methylated spirit or turpentine are necessarily dearer.

When slow-drying enamels are wanted, then they must be made of the nature of an oil varnish with melted resins, linseed oil, and turpentine, colored with the necessary pigment.

The following recipes will serve to show how these various materials may be used together to produce the various classes of enamels.

*For a cheap, quick-drying enamel paint.*—The base of this paint is made from common resin 30 lb., turpentine 5 gallons, resin spirit 5 gallons, and linseed oil 1 quart. This may be colored by adding sufficient of any of the pigments named above. To make this paint, it is best to break up the resin into small pieces and place them in a vessel which can be covered over to prevent the evaporation of the spirit. The other ingredients are then added and the mixture placed on one side until the resin is dissolved, stirring occasionally from time to time. It is not necessary to heat it, though heat of course will facilitate solution; but it is at the expense of the spirit, much of which will evaporate. When all the resin has dissolved, then the pigment may be added and the paint mixture sent through a grinding or mixing mill to insure thorough admixture.

*The best quick-drying enamel paints* are made, however, with methylated spirit as the solvent. A good base for such paints is made by taking 15 lb. of good orange shellac, 5 lb. of Manila copal, 1 lb. Venice turpentine, 1 lb. raw linseed oil, and 10 gallons of methylated spirit, mixing all together cold, and stirring well until all is dissolved. To the varnish liquid so made, the necessary amount of pigment is added. For blacks, nothing is better than 5 lb. of vegetable black and ½ lb. of spirit aniline black. For white, add 4 or 5 lb. Orr's white. Bright reds may be made from vermilionettes or royal reds. Any of the pigments which have been named above may be used to color spirit enamel paints.

*Slow drying enamel paints* are best made by adding

the required amount of coloring pigment. These varnishes are made by melting gum copal for best varnishes, or kauri or resin for cheaper qualities. The melted resin is then dissolved in hot linseed oil, and to the mixture is added sufficient turpentine to thin it down to the required consistency. The varnish so made is then ready for use. For fuller details reference should be made to one of the various works which deal with varnish making, such as Hurst's Painters' Colors, Oils, and Varnishes. Opaque pigments should be used in this class of enamel paints. The aniline or coal tar colors, owing to their insolubility in oil and turpentine, are not very suitable for coloring oil varnishes, and their use is best avoided. These slow-drying enamel paints take from 12 to 24 hours to dry, according to the varnish used. They leave a good, firm lustrous coat, which, in the majority of cases, is more durable than that which can be obtained from a quick-drying enamel paint. They are, however, not so generally useful; as a quick-drying paint is, on the whole, much more serviceable for use by the public, who often desire to handle objects almost as soon as they are painted.

## THE CARE OF THE SKIN.*

By James C. McGuire, A.M., M.D., of Washington, D. C., formerly lecturer on Dermatology at the Hospital School of Medicine, Louisville, Ky.; Dermatologist, Louisville City Hospital, etc.

That we may better appreciate the importance of the proper care of the skin, it is well to know something of this, one of the most important and complex organs of the body.

It is practically divided into two parts—the outer, cuticle, scarf-skin or epidermis and the deeper true skin or corium.

The epidermis is subdivided into the corneous layer, composed of flat, lifeless, colorless cells and the malpigllian layer (so named from the anatomist, Malpighi) of irregular shaped cells, developing to replace those of the outer layer that have been cast off. It is these cells that contain the coloring matter that causes the difference in hue in the European and African. The true skin or corium (from the Latin *corium*, leather) is divided into the outer papillary layer, made up of little elevations called papillæ, intended to give a greater amount of surface. It has been computed that there are about one hundred and fifty millions of these over the whole body. Below this is the reticulated layer (from the Latin *reticulatus*, net-like or latticed), made up of elastic interlacing fibers, the meshes of which become larger and larger, until we reach the subcutaneous tissue which connects the skin to the parts beneath.

The corium is well supplied with blood vessels, lymphatics, nerves, glands and hairs. The arteries from below send off little capillary loops, which ascend in the papillæ, then descend to become veins; they are called capillaries (from the Latin word *capillaris*, like a hair), they are so small and slender. Some of the nerves send off prolongations that become lost in the deeper cells of the epidermis. Others enter the papillæ to wind around and penetrate little bodies called tactile corpuscles. There are two varieties of glands—the sudoriparous and sebaceous. The former derives its name from two Latin words, *sudor*, sweat, and *pario*, I produce. They are made of tubes twisted in the form of a coil in the lower part of the corinm, with a duct, ascending through the entire thickness of the skin, to open upon its surface They are most numerous upon the palms of the hands, where there are about two thousand seven hundred to the square inch, or about two million three hundred and eight thousand over the whole body—an entire length of secreting tubes of two and one-third miles.

The sebaceous glands are made up of a mass of lobules, with a tube that usually enters a hair follicle. The hairs are regarded as modified epidermis. Almost the entire skin is provided with these appendages, except the palms, soles and some other parts. They receive their nourishment and growth from the hair papillæ, which they surround in the corium; occasionally they spring from the sides of the hair follicle; the total number in an average head of hair is said to be one hundred and twenty thousand. They are elastic, stretching about one-third their length, about one-four-hundredth of an inch thick, and will support a weight of two and a half ounces.

Sir Erasmus Wilson has reported the case of a young woman in whom the hairs covered almost the entire surface of the body and were thick enough to conceal the skin. Cases are reported in which the beard grew to the length of seven or eight feet. The hairs of the beard grow at the rate of about six inches in one year.

As to blanching of the hair in the course of a few hours, there are but few well-authenticated cases. In one mentioned in Flint's *Physiology*, the hairs turned white in the course of the night in a patient under observation in a hospital. The blanching is caused by the accumulation of air in the medulla and cortex of the hair. There is no diminution in the amount of pigment.

*The nails*, like the hairs, are derived from the epidermis. They are embedded in the skin at their lateral and posterior margins. The part under the nail is called the matrix, from which it grows. The semilunar shaped portion, near the root, is called the lunula. It is paler than other portions of the nail on account of having fewer blood vessels. Erasmus Wilson refers to a few "golden rules for the care of the nails. They should not be cleaned with any instrument whatever except soap and the nail brush, with an occasional use of the knife or scissors to the free end and an ivory presser to the scarf-skin at the root; when they are stained or discolored a little lemon juice is the best corrective."

So much for the anatomy of the skin. It is usually regarded simply as a covering for the parts beneath and to give shape to the form; but, as has been seen, it has functions peculiar to itself. It is an *organ of sensation*, especially of touch. This sense can be cultivated to a wonderful degree. We may see this exemplified in the blind asylums, where the inmates are taught not only to read but to study geography, botany, and anatomy by means of models through this sense alone. It has been related of a blind sculptor that he could model the most perfect likeness simply by touching the face, and of others who could even tell the color of objects in the same way.

The subject of *cutaneous absorption* is of interest, not only as a physiological fact, but from a therapeutical standpoint. A substance that has been applied to the skin and is capable of being absorbed is taken up by the orifices of the glands and follicles and between the cells of the epidermis. According to Prof. Liebrich, corrosive sublimate salve, one to one thousand, made up with lanolin, if rubbed into the skin, is so rapidly absorbed that the characteristic metallic taste, due to the absorption of the mercury, will be noticed in a short time.

*As an organ of secretion*, sweat is constantly poured out in the form of insensible perspiration—in amount, about two pints or pounds in twenty-four hours. It has a saline taste and alkaline reaction. Composed almost entirely of water, it regulates the temperature to a great extent hy the amount that is secreted. In the functional disorder of the sweat glands known as *bromidrosis*, it has an offensive, disgusting odor that will render a patient not only a burden to himself, but repugnant to every one with whom he comes in contact. It is said of Henry IV., of England, who suffered from this affection, that the ladies of his court would faint from the offensive odor when in his presence. Prof. Hammond relates the case of a woman who exhaled the odor of violets during an attack of hysteria. In another functional disorder of the glands, known as *chromidrosis*, it may be colored black, blue or red, or it may become phosphorescent; the body then becomes luminous in the dark.

The secretion from the sebaceous glands, known as sebum, is a semi-fluid substance containing 50 per cent. of fatty matter, and is intended to give softness to the skin. The so-called "flesh worms," or "grubs," are really masses of sebum which clog up the follicles; the little black heads are caused by an accumulation of dirt and pigment.

Considering the important functions the skin has to perform and the harm that will result from the non-performance of these functions, the importance of its proper care can hardly be overestimated. It is true that "beauty usually produces love, but cleanliness will preserve it." Cleanliness is absolutely essential to the correct performance of the functions of the skin and the preservation of the general health; the dust, secretions and the cast-off epithelial scales must be removed by frequent washing. This brings us to the subject of *baths and soaps*. The ancients indulged more freely in the bath than is the custom with us; the Romans, especially, fully appreciated the pleasures and necessity of the bath, and indulged in it to excess. They erected magnificent buildings, supplied with all the requisites for hot, cold and vapor baths; from the ruins, as we now see them, we can form but an inadequate idea of their splendor; buildings, including libraries, gymnasiums and baths, were free to the public. Women have endeavored to beautify their skin by bathing in milk and scented waters. To such an extent was this carried in Paris at one time that there was great scarcity of milk for the table. I know of a well-known prima donna who uses a quart of cologne in each bath.

I do not consider the daily application of the full-length bath for hygienic purposes necessary. Twice a week is sufficient to cleanse the skin of all external *debris;* more frequently than this is simply a luxury. The average Englishman would rather part with his tooth brush than his tub; his solicitous care of it is amusing; it must always be with his luggage; he will bring it across the Atlantic; will take it to the wilds of Africa or to the plains. Why, can he go to any place where he cannot procure a better bath than his "tub" can afford? but—"well, you know, it is so English." While traveling on the Northern Pacific Railroad, Montana Territory, some years ago, I heard an Englishman ask the baggage master for his tub, that he might indulge in a bath while the train waited half an hour for dinner. When it was refused him, he simply abused the blasted country, went to a neighboring hotel and took his plunge in the public bath tub. As the train moved off he ran after it, completing his toilet as he ran. He was either a very cleanly person or an extremely dirty one.

Not only is the daily full length bath unnecessary; it is harmful in many cases, depriving the skin of its natural unction, rendering it rough and liable to take on an eczema in those who are predisposed to this disease. The Turkish bath has done as much harm as good; it is of benefit, however, in some cases to stimulate the skin and thoroughly remove all external debris; in this respect it cannot be surpassed.

The hands, face and neck should be washed at least twice a day, and such confined portions of the skin as the armpits, once; the whole body twice a week, as I have already said, is all that is necessary. It should be known that there are certain diseases of the skin, such as eczema, to which water is absolutely poisonous; cases of this disease may at times be cured by simply protecting the part, and not allowing water to come in contact with it. After a cold bath use brisk friction, with a towel, not only to further cleanse the skin, but to excite the cutaneous circulation, and so draw the over supply of blood from the internal organs. Those suffering with heart troubles should abstain from the hot bath, as the heat will cause a determination of blood to the surface and so deprive the heart of its natural supply.

*Soap* may be defined as the product of the action of alkalies upon refined oils or fats. If the alkali is soda, the result will be hard soap; if potash, it will be soft. Soaps are of three kinds: Alkaline, when there is an excess of alkali, rendering it more or less caustic; neutral, when the alkali and fat are supposed to be exactly balanced; and the over-fatty. Their efficacy depends upon their power of rendering the natural unguent of the skin and debris soluble in water. The soap is decomposed and gives up part of its alkali, which unites with and removes this debris from the skin; the rest of the alkali dissolves the particles of epidermis that have performed their functions and are ready to be cast off. Only the best soap should be used for the toilet—that is, those that are unscented and transparent, for the foreign admixtures may irritate a sensitive skin; they should not contain an excess of alkali, and the fat should be pure and sweet. Probably the best is either the white castile, made with the best olive oil and soda, or Pears' unscented transparent soap. As to medicated soaps, they are, as a rule, valueless, for the quantity of the drug taken up is very small; it is in contact with the skin too short a time; the amount cannot be measured or its purity guaranteed. They should never be used without the advice of a physician.

There is a popular error that soap should not be used upon the face. There is no good reason for this belief; in fact, it is more important on the face than elsewhere; not only is the face the most exposed portion of the body, but there is a greater amount of secretion here than elsewhere to catch the dust.

It has been said that country girls wash their faces with soap, and do not have acne; city girls abstain from the use of soap, and do. Though this is exaggerated, I have met with cases that have been aggravated by neglect of this part of the toilet.

There is an old saying, "Women who paint their faces to seem beautiful do clearly deface the image of their Creator;" and yet they will frequently resort to any means that hold out the least hope of improving their complexions, such as plastering their faces with paste, enameling, binding it in raw beef, and even wearing medicated masks. The purpose of most of these applications is simply to conceal repulsive blemishes, which in the majority of cases could be readily removed by appropriate treatment. Such methods can only do harm; for if they do not directly injure the skin, they make it tender and much more apt to be affected by external agencies. To make their hands white and bloodless women have been known to spend the night with them suspended by means of pulleys.

I am frequently asked, are dusting powders harmful? Most of them are, for they are liable to contain lead, bismuth or other deleterious ingredients Plain starch, magnesia or corn starch farina are the least harmful. I advise against the use of any of them, as they will clog up the openings of the glands, and so are apt to prevent them from performing their proper functions. If the face is abnormally greasy, a little sulphate zinc, in water and alcohol as a lotion, will be found of benefit.

*Hair Dyes.*—As a rule these dyes will not act injuriously, except when they come in contact with the scalp itself, when they may cause some irritation. Black color may be produced by painting in a solution of nitrate of silver, and then exposing the hairs to the sunlight; to avoid staining the surrounding skin it may be washed with a solution of common salt. Prof. Kaposi mentions a hair dye that has been in use very generally in the East, among the Persians. It will produce all shades of color, from a light brown to dark black. "The remedy consists of the powder of the dried henna plant and of the powdered indigo plant. The first powder is formed into a thick paste by means of water, and spread on the hair; after the lapse of an hour this appears of a red color. A paste prepared from the powdered indigo plant is then spread on the first. Under the influence of warmth and moisture the black color becomes apparent on the hairs, covered with these two pastes, in the course of several hours. We have seen, even in the experienced hands of Dr. Pollak, a color produced which was some degrees removed from what was desired." Before beginning the use of hair dyes, read the experience of Tittlebat Titmouse, in Warren's "Ten Thousand a Year."

*Hair Restorers.*—The Massachusetts State Board of Health has had a large number of so-called hair restorers now in the market analyzed. It was found that all that were examined contained lead in varying quantities. For *falling of the hair*, our chief reliance must be in the use of local stimulating applications. Equal parts of tincture of cantharides and bay rum is an excellent application; it will not blister the scalp. The confidence with which a bald-headed man will use a hair restorer, recommended by a bald-headed barber, has been referred to as a sublime example of faith cure. It is of especial importance that the hygiene of the hair should be looked after—that is, the proper use of the shampoo, brushing, exposure to air and light, cutting and shaving, and in the use of pomades. *Shampooing* should be resorted to about once a month. The best shampoo is made of equal parts of saponis viridis and bay rum; it should be about the consistency and color of sherry wine. As it is frequently made up in the shops, it is a dark thick fluid, caused by the use of an inferior quality of soap. The mistake should not be made of applying the shampoo to the hairs alone, but the hairs should be separated and the liquid dropped upon the scalp, here and there, and then with the use of a little water rubbed thoroughly for five or ten minutes. Usually the shampoo is not applied with sufficient vigor. The hair should be dried and an ointment, such as sulphur, one drachm to the ounce, applied. *As to brushing*, a good stiff *brush* should be chosen, such as recommended by Dr. Jackson. "A properly made brush has its bristles placed in little clumps or groups in such a manner that the little bristles of each group are larger than those of the periphery. The bristles are well set into the back of the brush and the groups are wide apart." With such a brush the hair can hardly be brushed too much. Not only should the fine tooth comb be interdicted, but any form of comb is bad for the scalp; it is not necessary, as the part can be just as well made by means of two brushes. Wigs and false hair heat and sweat the scalp, and deprive the hairs of the sunlight and air which are necessary to their healthy growth.

*Hirsuites.*—Women suffering from an abnormal amount of hair will resort to any means to get rid of this blemish. They usually shave or extract the hairs, but this only acts as a stimulant to renewed growth. So-called depilatories are worse than useless; they contain ingredients that have the power of dissolving the hair; but, if we remember the anatomy of the skin, it is evident that it is impossible for them to reach the papillæ, from which the hair receives its nourishment, without destroying the whole thickness of the skin. The only means by which the hairs can be permanently removed is the method resorted to by dermatologists, known as electrolysis. A fine needle is inserted into the hair follicle down to the papillæ, which is destroyed by the passage of an electric current from the negative pole of a galvanic

* From the *Virginia Medical Monthly.*

battery. Five thousand hairs have been removed from a lady's face by this means, resulting in permanent relief of the trouble.

*Lotions for the toilet*, as found in the shops, are liable to contain mercury. This may be absorbed and produce symptoms of constitutional poisoning. What is known as "flake white" is made by mixing carbonate of lead with rose water. Cases are not infrequently reported of women, who have been poisoned, showing symptoms of the constitutional effects of the lead. Some of the symptoms are delirium, abdominal pain, a peculiar drop of the wrist, and a characteristic blue line along the edge of the gums.

*Some Popular Errors in Regard to Skin Diseases.*—Though many of our colleges completely ignore the study of dermatology, the leading universities have awakened to the fact that it is a snbject not to be neglected, and examinations are now even made compulsory. It is just as important to make a correct diagnosis between an eczema and psoriasis as it is between scarlet fever and measles, variola and varioloid. It is presumable that the study of cutaneous diseases is neglected to such an extent on account of their unimportance; but in refutation of this, one has only to refer to the literature of the subject; to such books as Hebra's Diseases of Skin, in five volnmes, of three or four hundred pages each; to recall such names as Hebra, Kaposi, Neuman, of Vienna; Sir Erasmus Wilson, Tilbury Fox and Addison, of England; Bulkley, G. H. Fox, Morrow, Piffard, White, Hyde, and a host of others in this country—men who have devoted their life study to this subject, and who have no snperiors in any branch of the medical profession.

Familiar appellations for skin diseases are not confined to the laity. The most diverse, ridiculous and unmeaning terms have been applied to these affections, such as *tetter*, that usually refers to eczema, or may mean psoriasis or lupns. *Bakers' itch*, *grocers' itch*, *milk crust*, *tooth rash*, are also used to designate some form of eczema.

*Liver spots* may refer to chloasma, a pigmentary affection, or to tinea versicolor, a vegetable parasitic disease.

*The itch*, to scabies, a disease caused by an animal parasite, known as the acarus scabiei. The expression, *army itch*, would lead one to snppose that it was distinct from scabies, yet we recognize it as the same disease.

*Blood boil* has no scientific meaning and is applied to various diseases.

*Hives* is recognized by some as urticaria; by others as varicella (chicken pox).

*Shingles* means herpes zoster, an acute disease, characterized by an eruption of groups of vesicles upon an inflamed base along the course of certain nerves.

*Prickly heat* usually refers to a disease known as miliaria, an affection of the sweat glands.

*Dandruff*, to the dry form of seborrhœa of the scalp.

*Black heads* (*flesh-worms*), to comedo, a collection of sebaceons matter in the distended sebaceous glands. The little black heads are caused by the accnmulation of dust and pigment.

*Ringworm* is a vegetable parasitic disease, caused by the trichophyton fungus, and is known as trichophytosis.

*Barbers' itch* is caused by this same fungus upon the bearded portion of the face, and is designated by the term tinea sycosis.

*Fish skin disease* is a congenital affection characterized by dryness and scaling of the skin. Its proper name is ichthyosis.

*Chap* is usually a mild form of eczema, attended with cracking of the skin.

As to the etiology of skin diseases, how often we hear the expression, *bad blood*. Has this term any meaning? If it has, it must mean a depraved state of the blood that can be recognized by chemical reagents or by the microscope; but Prof. Bulkley says "Chemical and microscopical studies fail to show there is bad *blood* in any of the diseases of the skin. It is snpposed the impurities in the *bad blood* find exit through the skin, and in so doing take the form of an ernption; consequently it is harmful to remove them. Patients frequently express themselves as very solicitous about the sudden cure of a skin disease. The consequence, in their opinion, might be disastrous by the *driving in* of a disease that might attack some internal organ. Nothing could be more absurd, for it is absolntely impossible, in this sense, to either drive in or drive out a skin disease. The blood has little to do with these diseases. There are affections as peculiar to this organ as to any other, entirely localized, depending upon changes in the tissues themselves. Others are caused by parasites; still others by nervous disturbances. It is evident that the much lauded *blood purifiers*, for cutaneons diseases, are, to say the least, useless. A patient may get well while taking these quack nostrnms; the fact is then extensively advertised. This is about on a par with the announcement of lottery companies of the fortunate individuals who have obtained prizes. The tens of thousands who are not so fortnnate are never heard from."

The majority of skin diseases are regarded as contagious, and the fear is expressed that those who come in contact with the afflicted are liable to become affected; but this is far from the truth, for out of the hundred and more diseases that may affect this organ, only two or three, besides the parasitic diseases, are really contagions.

As there are so many popular errors in regard to cutaneous diseases, the following *aphorisms* may be of some interest. The statements are made either upon the evidence of well recognized authorities or as a result of my personal experiences:

I. You cannot be successful in treating diseases of the skin without a thorough knowledge of general medicine. This, I think, will be accepted as a self-evident proposition.

II. You cannot cure them too qnickly.

III. If they are cured, they will not act deleteriously upon any internal organ. Hebra says: "Our warmest edeavors are to find means of terminating these diseases as speedily as possible. Were we only in possession of remedies which produce cures thus rapidly we should have no anxiety in regard to the appearance, from this cause, of metastasis, or of any other consecutive disease."

IV. Arsenic is not a specific for cutaneous diseases; in fact, it is less frequently used by those who have made a special study of these diseases than by the general profession.

V. You cannot drive in or drive out diseases of the skin. "At this day no educated physician believes in employing medicine with a view to either the so called 'driving out' or 'driving in' of a disease of the skin."—*Hyde*.

VI. The great majority of these diseases, contrary to the general idea, are not contagious; only one or two, besides the parasitic diseases, out of the hundred and more that may attack this organ.

VII. Freckles are not always produced by the sun's rays. Cases are reported where they have appeared upon the portions of the body of young girls that have never been exposed to the direct rays of the sun.

VIII. Tinea tonsurans (ringworm of the scalp) does not ocenr in adults, though Tilbury Fox has reported one such case. If it ever ocenrs, it is extremely rare. Neither Duhring nor Piffard ever met with a case.

IX. Tinea versicolor, another parasitic disease, does not ocenr in childhood. "Children are exempt."—*Weyl* and *Gaber*. Neither Duhring nor Liveing ever saw a case.

X. Acne does not occur in childhood. Mild cases of this disease are not the easiest to cnre.

XI. Chloasma (liver spots) never occurs before puberty. The disease is not caused by diseases of the liver.

XII. Bromidrosis does not necessarily mean bad-smelling sweat. The odor may be that of violets or pineapples.

XIII. Scabies and tinea versicolor do not appear upon the face of adults.

XIV. Eczema marginatum is not an eczema, but is a parasitic disease.

XV. Leprosy, as we now understand the disease, is not described in the Bible. Leprosy is not as dangerous to the community as tnberculosis, according to Beaven Rake, Superintendent of the Trinidad Leper Asylum. It is not proved that the disease has been conveyed by vaccination.

XVI. You cannot cure an eczema (tetter) by internal treatment alone. Hyde says, once fully persuaded of this important truth, the physician should be capable of managing the complaint without mental bias.

XVII. Do not apply water to an eczematous surface, as a rule. It is poisonous to acute ernptions.

XVIII. Do not expect the same effect in different persons from the same prescription; that which is of benefit in one case may aggravate an ernption in another.

XIX. Do not use a sponge in making applications to the skin. It cannot be kept clean and pure.

XX. Depilatory remedies cannot permanently remove the hairs without scarring the skin.

XXI. Pruritus does not simply mean itching as a symptom; it may refer to an idiopathic disease that is known by that name.

XXII. Bad blood is not the chief cause of cutaneous diseases; according to most authorities, it can hardly be classed as an etiological factor.

XXIII Scales and crusts are not synonymous terms.

XXIV. Drug eruptions are not due to "salivation of the system" with the drug. A few grains of iodide potash may cause an eruption as well as a hundred.

Idiosyncrasy has been defined as an individual peculiarity which renders one susceptible to certain effects not produced in others. In this way, every one is susceptible to certain ill effects from certain foods; therefore those things which your stomach has taught you it will not digest should be avoided. Shell fish, strawberries, oatmeal, etc., have been known to produce urticaria. Confectionery may aggravate an acne or an eczema. It is well to remember to keep the teeth in good condition; to have regular hours in partaking of food; not to eat to excess; never to dine alone; to eat slowly and chew thoroughly. Though it is impossible to lay down any fixed precepts of diet, there are certain articles that should be avoided by those suffering with cutaneous diseases.

| PERMITTED. | TO BE AVOIDED. |
|---|---|
| Water plentifully *between* meals; cup of very *hot* water before breakfast; small amount bottled table water at meals; one cup of coffee or tea, well diluted, for breakfast; milk *ad libitum* if it agrees.<br>Fresh fish and raw oysters; beef, lamb, mutton, chicken, turkey, fresh game, boiled eggs.<br>Cooked vegetables and fruit in season; cold bread, toast and crackers, crusbed wbeat, bominy and rice.<br>Tobacco in moderation to those accustomed to its use. | Stimulants, especially fermented; liquors; all beer, wine, cider, etc.; all fried articles; salted meats, pork, veal, lobster, cooked oysters, crabs, eggs, except boiled, sausage, potted meats, rich gravies and soups, uncooked vegetables, cabbage, corn and turnips, pastry, confectionery, preserves, nuts, cbeese, rich salads, pickles, desserts, bot bread and cakes, melted butter and buckwheat cakes. |

## THE METHODS OF TESTING FATS AND OILS.*

By DR. ERNEST MAILLIAU, Director of the Government Testing Laboratory at Marseilles, France.

THE French government and the Regency of Tunis have taken the opportunity of the great American World's Fair to bestow upon us the honor to communicate to you by conference and by practical experiments the analytical methods which we use in France to recognize the purity of the fatty bodies. I hope that you will give us your kind indulgence and facilitate our modest efforts with the good will which you have already shown to all our fellow conntrymen who have come to you with the disinterested object of strengthening the scientific bonds which unite the two republics.

If the French and Tunisian governments have chosen me for their representative, it is only because I direct the ministerial laboratory of technical tests founded for the purpose of studying all the prodncts of the colonies and Mediterranean district, and especially oils and fatty matters, as well as the different products which are connected with them, and that I have acquired some knowledge of the subject by long practice and continual investigations.

This is the only laboratory of its kind, and has been placed at Marseilles, the great seaport of France and port of entry for colonial products.

* Read at a special meeting of the Chemical Section of the Franklin Institute, June, 1893.—*From the Journal.*

The difficulties of chemical analyses of fatty matters are greatly increased, not only by the slight differences which characterize the various glycerides, but also by the numerous cases of isomerism, and the phenomena of oxidation and fermentation, which modify their molecular structures, by the resins and the essential oils which they contain, and also by the foreign matters which injuriously affect them, and the composition of which varies infinitely according to the nature of the soil from which the plant draws nourishment, by the method of extraction, age, and a thousand other causes needless to mention.

Since the methods of communication have been facilitated, and exchanges have become more numerous, the different markets of the world have been flooded with fatty matters presenting different characters, though of the same nature as those to which industry and commerce have been accustomed.

We have been led to seek methods of analysis for oils not by their impurities, which vary according to their origin, but by the examination of their principal constituents, which remain practically the same for the same species.

For example, it is now well known, and we state with pleasnre, since we have made the first of these observations, that the olive oil of Tunis, Morocco and other provinces often presents the character of adulterated oils if analyzed without proper precautions or by old processes.

Accordingly, the greater nnmber of governments and large companies have been obliged to modify their specifications to control the purchases necessitated by their wants by methods better adapted to the needs of commerce and the progress of science. Accordingly, before trying the action of chemical reagents upon this product, so extremely variable and alterable, it is indispensable for obtaining precise resnlts to submit the material to a purification preceded and followed by a number of filtrations. By thus removing the impnrities which when present alter the results, we bring back the fatty bodies of the same species to a type which is always practically the same. To reach this end we work sometimes by washing with hot distilled water, sometimes with strong or dilute alcohol, sometimes we refine the fatty matter by the use of caustic soda lye (containing ten per cent. sodium hydrate), employed in the proportion of ten per cent. of the fat. The emulsion is poured npon a saturated solntion of sodium chloride, and by the action of gentle heat the different parts separate and the clear oil holding in suspension insoluble particles of soap rises qnickly to the surface.

It is well to note that fatty matter, even when neutral as has been demonstrated, dissolves notable quantities of alcohol, which must be eliminated, if this method of washing has been employed. The process of the operation cannot be fixed definitely; it varies according to the nature of the impurities and the object of the research.

It is certain, for example, in determining the amount of volatile acids, we must be content with the simple filtration, and that when examining the oils of the cruciferæ we must not use caustic soda, which changes organic sulphur to a soluble sodium sulphide. Having finished the preliminary operations, we may, according to circumstances, operate directly on the neutral fat or the fatty acids prepared from it.

The fatty acids collected in the nascent state (that is to say, when they rise to the surface in a pasty mass) have much stronger chemical affinities than when melted and dehydrated. This difference is particularly remarkable in the examination of cotton seed and sesame oils. The black and red colorations obtained very clearly with a mixture of five per cent. upon the nascent fatty acids are not visible with the same fatty acids when melted.

The purification skillfully made does not destroy the chemical characters of the oil, as is easy to verify, by treating comparatively the same oil containing five per cent. of the fatty matter, the presence of which we wish to demonstrate. The reactions of the added material are in general intensified by these different treatments.

By working upon the fatty acids of the neutral oils, I have been able to demonstrate the purity of certain fatty matters which appeared adulterated and in which the presence of cotton seed and sesame oils was indicated by the old methods which I have been able to revise.

(*Circulaire du Ministre de la Marine Francaise*, en date du 26 Juillet, 1892. *Rapport du Resident-general de Tunisie*, en date du 9 Mai, 1892. *Circulaires des Ministres du Commerce et de l'Agriculture*, etc.)

I well know that in practice these preliminary operations may appear very tedious, but I do not advise their use except in cases where adnlterations have been indicated by the usual methods, and it is desired to make the proof positive.

Besides, I cannot understand why a chemist has always been expected in the analysis of such delicate materials as fats to discover an infallible reagent, a single drop of which will immediately turn olive oil green, peanut black, sesame red, etc., so that any inexperienced person could discover adulteration and bring the perpetrator to justice. This requirement of the most difficult part of verification is absolutely incomprehensible and is only to be excused by the ignorance of those who ask it.

We will now proceed to the study of each oil in particular. We will pass rapidly over those which possess only a secondary interest, so as to lay greater stress upon those which are the object of a great number of sophistications, as for example olive oil. But in the first place we will indicate rapidly the general processes, physical and chemical, which are used for the identification of the various fats.

### GENERAL METHODS.

(1) *Specific Gravity.*—Specific gravity is taken with accuracy by the Mohr balance, which is too well known to need description. It must be borne in mind that the specific gravity of the same fat varies greatly with individual samples, and this physical character is not sufficient to allow us to decide on purity or adulteration.

(2) *Action of Nitrous Fumes.*—We owe to a Marseilles gentleman, M. Poutet, the first serious proposition for recognizing certain adulterations of olive oil.

It was designed especially to discover the presence of poppy seed oil, with which at that time olive oil was very frequently adulterated, and for which the process gave good results.

It is based upon the transformation of the olein to its isomeric modification elaidin, by the action of nitrous fumes. It has been modified by other chemists, Messrs. Boudet, Faure and Cailletet. The process of Mr. Cailletet was most sure and simple, and we use it in the following manner:

We take a tube 10 cubic centimeters long, $2\frac{5}{10}$ cubic centimeters wide, in which are 20 cubic centimeters of the fat to be analyzed. Six drops of pure sulphuric acid at 66° B. are added, the tube shaken one minute and then nine drops of nitric acid C. P. 40° B. are added, after which the tube is again shaken and then plunged in boiling water, where it is left exactly five minutes, after which it is cooled in a water bath at 8° to 10° C., whence it is taken at the end of two hours, and the condition of the mass observed. It is well to note the different colorations obtained. First, after the addition of the sulphuric acid; second, after the addition of nitric acid; third, after the removal from the water bath; and fourth, after chilling.

(3) *Sulphuric Saponification.*—M. Maumene proposed to observe the rise of temperature produced by rapidly mixing sulphuric acid with oil. The manner of applying the process in our laboratory is as follows: Fifty grammes of the fat for analysis are weighed into a conical glass of 100 cubic centimeters capacity. The temperature is noted, and ten cubic centimeters sulphuric acid, 66° B., at the same temperature as the oil, is added. The two liquids are stirred together for one minute. An accurate thermometer is then immersed in the upper portion of the mass, stirred slowly, and the maximum temperature noted. The initial temperature must be at least 20° C. In order to obtain exact results, it is well to make several determinations and take their mean when the variation does not exceed 2° C.

To obtain the relative sulphuric saponification, we note the rise of temperature obtained with fifty grammes of distilled water at the same temperature as the oil and ten cubic centimeters of the same sulphuric acid. The number of degrees obtained by the oil is multiplied by 100 and the product divided by the number of degrees obtained with water. This process has the advantage of giving results nearly constant with acids of somewhat different strength. I have tried the application of the sulphuric saponification with semi-solid vegetable oils by working at 2° or 3° above their melting points, and the results have been very satisfactory, especially for palm nut oil and cocoanut oil, because the differences between them and the fluid oils often amount to 45° or more as, for example, between palm nut oil and sesame oil.

(4) *Iodine Number.*—In the fatty bodies there are members of unsaturated series, as, for example, oleic acid, which can absorb into its molecule as many atoms of the halogens as there are lacking atoms of hydrogen for complete saturation. The iodine number of olive oil varies between 80 and 84, that of peanut oil is 97, while that of cotton-seed oil is 108. These differences then allow, within certain limits, the determination of the purity of the various fats. We apply the Hubl method as follows:

*Solutions required:*

| | | |
|---|---|---|
| Alcoholic solution of iodine..... .... | 50 | gr. |
| Solution of hyposulphite of sodium.. | 24·8 | " per liter. |
| " " mercuric chloride..... | 60 | " " |
| " " potassium iodide ..... | 100 | " " |

Five grammes of fatty acid are weighed out, diluted to 100 cubic centimeters with alcohol 92 per cent.; ten cubic centimeters of the solution are taken and to it added 20 centimeters of the iodine solution and 15 to 20 cubic centimeters of the solution of mercuric chloride. The flask is closed and allowed to stand three hours. Twenty cubic centimeters of the potassium iodide solution are added and the excess of iodine titrated. When the brown coloration begins to disappear, a few drops of starch solution are added and then hyposulphite until color disappears.

We will pass in silence the other indices, such as that of acetyl, which is of use only to discover castor oil.

(5) *Freezing Point.*—The freezing point is easy to determine by means of a thermometer and a freezing mixture.

(6) *Melting Points of Fatty Acids.*—The dry and melted fatty acids are sucked into a capillary tube. After solidification the tube is placed beside the bulb of a sensitive thermometer and immersed in a beaker of water, the temperature of which is raised very slowly.

The reading of the thermometer is taken the instant the body passes from the solid to the liquid state.

(7) *Solidification Point of Fatty Acids (Titer).*—The dried and melted fatty acids are placed in a tube 15 centimeters long and 2 centimeters in diameter, which is suspended in a wide-mouthed bottle with a perforated stopper. A thermometer graduated to tenths is inserted so that the bulb reaches the center of the material. At the moment solidification commences a circular movement is given to the thermometer, stirring the whole mass; the thermometer is then left at rest and carefully watched till the mercury ceases to rise; the reading then taken gives the point of solidification, or titer, conventionally adopted.

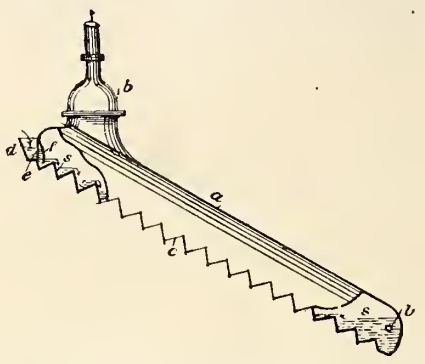
(8) *Saturation.*—We operate on five grammes of the melted and dried fatty acid with a solution of normal caustic soda. The number of cubic centimeters absorbed gives the saturation number.

(9) *Solubility in Absolute Alcohol.*—We determine this in the following manner: The fat is neutralized by agitating in a closed separating funnel for thirty minutes with twice its weight ninety-five per cent. alcohol. After settling it is drawn off and the alcohol held in solution driven off at low temperature, after which it is agitated at 15° C., or at a few degrees above the melting point; or if solid at 15°, with twice its weight of absolute alcohol. A known quantity of this alcohol is evaporated, the residue weighed and the quantity of oil dissolved by 1,000 grammes of alcohol is calculated.

(*To be continued.*)

## "CASCADE" PLATINUM CONCENTRATING STILL FOR SULPHURIC ACID.

IN the design of platinum concentrating stills, the chief point to be aimed at is a thin layer of acid distributed over a large heating surface. In the apparatus illustrated, which has been patented by G. Siebert, of Hanau a/M., this is effected by an inclined still, the bottom of which consists of a series of steps. The acid enters at *d*, and flowing down the stepped bottom passes out at *i* into a cooler. The effect of the steps is threefold: first, it spreads the acid evenly over the whole width of the still; second, it gives a largely increased heating surface for the same length of still; and third, it causes the gradual concentration of the acid, each step forming a separate concentrating pan, with the effect that the loss of platinum during working is reduced, as the highly concentrated acid only comes in contact with the lower part of the still.



At the chemical works of H. Blank at Hankelsablage, Konigs-Wusterhausen, the following results have been obtained in 24 hours at the normal rate of working:

| | | |
|---|---|---|
| 5,000 kilos. | Acid of 97 per cent. $H_2SO_4$. | Distillate 40°—45° B. |
| 6,000 kilos. | Acid of 96 per cent. $H_2SO_4$. | Distillate 35°—40° B. |

and with forced working,

| | | |
|---|---|---|
| 8,000 kilos. | Acid of 95 per cent. $H_2SO_4$. | Distillate 20°—25° B. |
| 9,000 kilos. | Acid of 94 per cent. $H_2SO_4$. | Distillate 18°—20° B. |
| 11,000 kilos. | Acid of 93 per cent. $H_2SO_4$. | Distillate 12°—14° B. |

all at 15° C.

With a production of from 8,500 to 8,600 kilos. of sulphuric acid containing 93 per cent. to 94 per cent. monohydrate, in 24 hours, the coal consumption was 14 per cent. of the weight of acid produced.

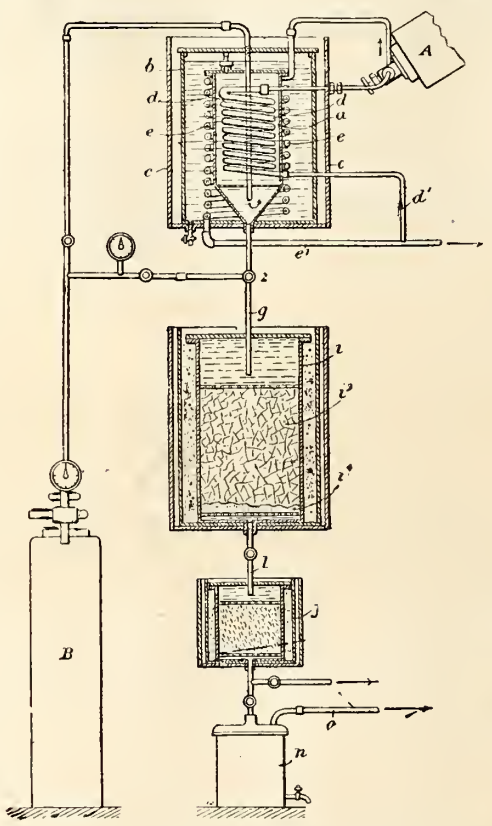
Further figures are given, comparing the Cascade still with those of Delplace and Prentice.

The loss of platinum after concentrating 242,687 kilos. of acid was too small to be determined. The still weighs 23·6 kilos., and is 1·55 m. long by 50 cm. wide, the fall being 25 cm.—*Chem. Zeit.*

## APPARATUS FOR SEPARATING DISSOLVED SUBSTANCES WITHOUT EVAPORATING THE SOLVENT.

C. WEITENKAMPF, Berlin, Germany.

THE principle of the invention consists in the application of great cold to the solution to separate the dissolved substance, and afterward allowing the mixture to run through layers of filtering substance to retain the separated substance, the pure solvent running away. The figure shows the apparatus in sectional elevation, where *a* is the reservoir enveloped by a larger reservoir, *b*, which in turn is surrounded by a casing, *c*, packed with sawdust or other suitable non-conductor. The reservoir, *b*, contains a suitable cooling mixture, and both *a* and *b* are traversed by worms, *d* and *e*, through which carbonic acid is passed from the holder, A, the outlets, $e^1$ and $d^1$, running away to a cistern. Carbonic acid is passed into the solution in *a* from the holder, B, until the liquid is saturated, the tap, 2, is then opened to permit the saturated liquid to enter the jacketed filtering vessel, *i*, containing the filtering medium, which consists of a mass of charcoal, $i^3$, upon a layer of wading, $i^4$. The purified solution, after passing through the first filter, is led into a second similar filter, *j*, by the pipe, *l*, to effect a further purification, the pure solvent being finally received into the holder, *n*, while the carbonic acid gas is led away by an outlet pipe, *o*, for use over again.



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## CONFLAGRATIONS OF WORLD'S FAIR BUILDINGS.

THE World's Fair grounds have been the scene of several disastrous conflagrations. The first and most notable was that of July 10, 1893, when the cold storage building was destroyed, with the loss of fifteen lives.

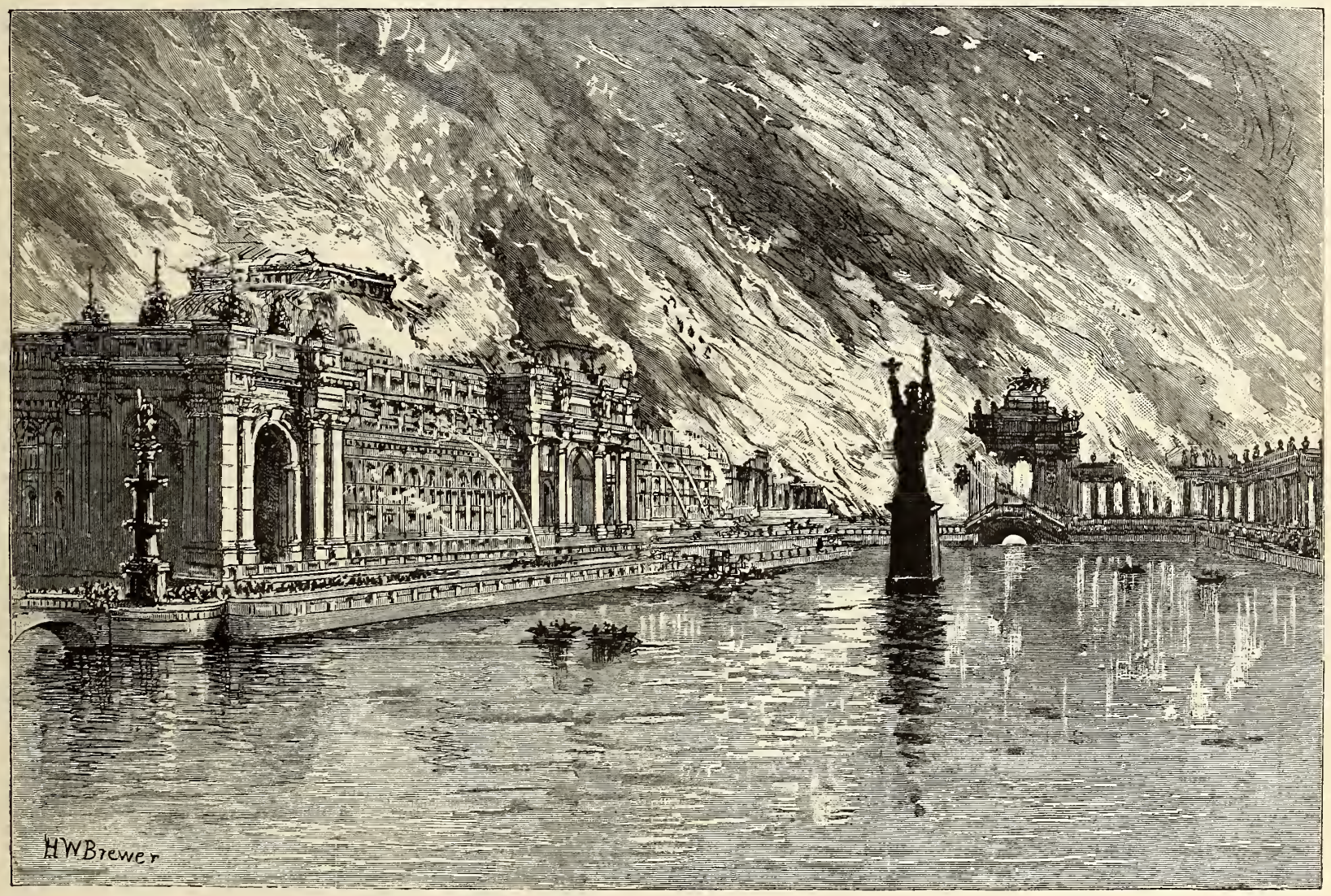
This fire deprived the Exposition of a beautiful building and an interesting exhibit as well. Considering the frail method of construction of the buildings in the Columbian Exposition, it is fortunate this was the only fire of importance during the Exhibition. As a safeguard, a special fire department was organized and equipped with the latest appliances for fighting fire, and the system of water supply and fire alarms reflected the highest credit upon the engineers in charge. Every possible care was used to prevent fires and to extinguish them quickly whenever they occurred.

The Manufactures building, with its almost inestimable treasures of art and industry, was patrolled from the roof to the vaults beneath the floors, by Columbian guards whose faithfulness to duty was assured by electrical signaling and registering devices. After the Fair closed for the first few weeks the fire precautions were unabated, but gradually the number of guards decreased until at last only a handful remained while the grounds were thrown open to the public. The World's Columbian Exposition Company passed out of control and the management was assumed by the South Park Commissioners. The result of this lack of adequate fire protection has been a most extraordinary series of fires, the origin of which is believed to have been incendiary. The motive for these crimes is variously stated. By some it is thought the dealers in second-hand building materials have had a hand in it, as they are interested in hurrying up the South Park Commissioners in winding up Jackson Park affairs and the sale of the buildings. Others suppose that tramps fired the buildings, either by accident or out of pure mischief. It would be strange if some of the fires were not due to individuals who take delight in seeing a blaze, when it is remembered that it was seriously proposed by some of the Chicago engineers and architects, before the close of the Fair, to have the buildings burned up singly to the delight of thousands of excursionists.

On January 8 occurred a fire in which the Peristyle, Music Hall and Casino were destroyed and the Manufactures building injured. At first this fire was supposed to have entailed a loss of $1,500,000, but this sum was afterward largely reduced. One life was lost. The fire started in the Casino and moved north along the Peristyle, burning en route the beautiful Columbian Arch, with its splendid quadriga, representing the "Triumph of Columbus." Then the Music Hall perished in turn and the flying firebrands soon set the huge roof of the Manufactures building on fire. The extreme risk connected with fighting the conflagration from such a dizzy height (200 feet), enveloped in smoke and flying sparks, can be seen by reference to our engraving. At length the fire was subdued, but the glory of the Court of Honor had departed forever.

On February 14, a fire started at 11 A. M., in the colonnade between the Agricultural building and Machinery Hall. The whole colonnade was destroyed, but the buildings on either side were saved. On February 18 the Illinois State building was partly destroyed by fire. This fire, like the preceding ones, was believed to be of incendiary origin. The chief danger connected with this fire was the risk to the Field Columbian Museum, the collections of which are now installed in the Art building. This edifice was fortunately saved. On February 24, fire was discovered in the dome of the Agricultural building at 7 A. M., and soon the whole roof was blazing. The destruction of the dome has rendered the beautiful building an eyesore. The Court of Honor now little resembles that glorious creation which astonished all beholders.

What little of the beauty remained in Jackson Park after the close of the Fair has been destroyed, and the sooner the dangerous structures which are a menace to life and property are removed, and the park restored to its pristine state, the better.




BURNING OF THE WORLD'S FAIR BUILDINGS, CHICAGO.

MORTALITY AMONG HOSPITAL NURSES.—A healthy girl of seventeen, devoting herself to hospital nursing, dies on the average twenty-one years sooner than a girl of the same age moving among the general population, and a hospital nurse at the age of twenty-five has the same expectation of life as a person at the age of fifty-eight in the ordinary community.

## THE ART OF BOOK AND NEWSPAPER ILLUSTRATION.*

By HENRY BLACKBURN.

*Lecture I.*

EIGHTEEN years ago, in this room, the general question was discussed "whether, in the matter of book and newspaper illustration, we are really 'keeping pace with the times;' whether those who provide the illustrations, which are tossed from steam printing presses at the rate of several thousand an hour, are doing the best work they can." The meeting was largely attended by experts, and the general conclusion arrived at was, that much remained to be done.

Thus in 1875 it was admitted, almost without dissent, that the system of illustrating books of travel and scientific research by means of wood engravings was "too elaborate and costly;" that, in consequence, there was much valuable material that never saw the light, and that in the case of news the public was continually deprived of what it would most care to see.

In the illustration of newspapers, it was further argued that there should be a clearer distinction between fact and fiction, between illustrated news and pictures. The exact words may be thought worth repeating:

"In the production of illustrations we have arrived at great proficiency, and from London are issued the best illustrated newspapers in the world. But our artistic skill has led us into temptation, and by degrees engendered a habit of making pictures when we ought to be recording facts. We have thus, through our cleverness, created a fashion and a demand from the public for something which is often elaborately untrue.

"Would it then be too much to ask those who cater for (and really create) the public taste, that they should give us one of two things, or rather *two things* in our illustrated papers, the real and the ideal?

"First. Pictorial records of events in the simplest and truest manner possible.

"Second. Pictures of the highest class that can be printed in a newspaper.

* Three lectures delivered before the Society of Arts, London, December, 1893. From the *Journal* of the Society.

"Here are two methods of illustration which only require to be kept distinct, each in its proper place, and our interest in them would be doubled. We ask first for a record of news and then for a picture gallery; and to know, to use a common phrase, *which is which.*"

At the time referred to, drawing on the wood block and engraving was almost universal—instantaneous photography was in its infancy, "process blocks," that is to say, mechanical engraving, was very seldom employed, and (for popular purposes) American engraving and printing was making great strides.

Let us now glance at some of the changes which have taken place in illustration (bridging over a distance of nearly twenty years), and consider the work of the illustrator, the photographer, and the maker of blocks, as presented in books and newspapers at the end of 1893; speaking principally of topical illustrations, on which so many thousand people are now engaged.

It may seem strange at first sight to include "newspapers" in the title of these lectures; but the fact is that the weekly newspapers, with their new appliances for printing, and in consequence of the cheapness of good paper, are now competing with books and magazines in the production of illustrations which a few years ago were only to be found in books. The illustrated newspaper is one of the great employers of labor in this field, and distributers of the work of the artist in black and white, and in this connection must by no means be ignored. The post office carries a volume of 164 pages (each 16 by 22 inches), weighing from two to three pounds, for a halfpenny. It is called a "weekly newspaper," but it contains, sometimes, 100 illustrations, and competes seriously with the production of illustrated books.

In the next lecture we shall see how the illustrations of one number of an illustrated newspaper are produced; what part the original artist has in it, what part the photographer, what part the wood engraver.

It was time, perhaps, that the "Society for the Encouragement of Arts, Manufactures, and Commerce" should take into consideration the state of book illustration in the present day. The words which head the proceedings of this society are singularly applicable; the "Art, Manufacture, and Commerce" of a book is well worth examining.

The modern publisher, it may be said without offense, understands the manufacture and the commerce of a book better than the art in it. And how should it be otherwise? The best books that were ever produced, from an artistic point of view, were inspired and designed by students of art and letters, men removed from the commercial scramble of life, and to whom an advertisement was a thing unknown! The ordinary education of a publisher, and the multitude of affairs requiring his attention, unfit him for the task of deciding whether an illustration is good or bad; or how far—when he cheapens the production of his book by using photographic illustrations ("snap shots" from nature)—he is justified in calling it "art."

It would be difficult, I think, to point to a period when so much bad work was produced as at present. The causes are not far to seek. As matters stand at present, the beautiful processes for the reproduction of drawings for the type press are scarcely understood by the majority of artists, publishers, authors or critics. It is the misuse of these processes which is dragging our national reputation in the mire. Our best artists have neither the time nor the inclination to make themselves acquainted with the methods, and it is hardly to be expected that a reviewer who has a pile of illustrated books to pronounce upon should know the reason of the failures that he sees before him. Thus the public is grievously misled by those who should be its guides as to the value and importance of the new systems of illustration.*

The deterioration in the character of book illustration in England is a serious matter, and public attention may well be drawn to it. The first and most serious difficulty to contend against is the comparatively low estimate of this class of work, and the competition of photographs. The second is the want of good technical education in this direction. Students leave art schools by hundreds not properly equipped for the business of life. The business of many will be to contribute in some form to the making of pictures and designs to be multiplied in the press; and, in order to learn the technique and obtain employment, some of the most promising pupils have to fall into the ways of the producers of cheap illustrations, Christmas cards, and the like. On the other hand, a knowledge of the mechanical processes for reproducing drawings (as it is being pressed forward in technical schools) is leading to disastrous consequences, as may be seen on every railway bookstall in the kingdom.

It is the special purpose of these lectures to inquire into the conditions under which process illustrations (to use the common phrase) are now produced, and to see how far, and in what way, we may obtain the best results.

It cannot have escaped observation that in the various lectures, demonstrations, and discussions held under the auspices of the Society of Arts, on the subject of book illustration, little has been said about the illustrator, upon whom so much in the future will depend. In May, 1882, Mr. J. Comyns Carr gave three Cantor lectures on "Book Illustration" (old and new) in which the subject was treated historically, and in which the wood engraver's art was most considered. In 1878, and in 1884, Mr. Thomas Bolas gave several Cantor lectures with practical demonstrations; in 1878, on "The Application of Photography to Printing Surfaces," and 1884, on "Improvements in Photo-Mechanical Printing Processes." And during the last ten years several excellent papers have been read on Wednesdays on artistic and decorative illustration, notably by Mr. Walter Crane and Mr. L. F. Day; also one in 1891, when the whole *modus operandi* of the production of a daily illustrated newspaper was made plain before you by Mr. Carmichel Thomas, of the *Graphic*.

All these papers, valuable as they are for reference and help, leave, I think, much to be said as to the illustrations of to-day from the artists', the authors', and the publishers' point of view.

First. As to line drawing for reproduction by the type press. It cannot be sufficiently borne in mind—I am speaking now to students who are not intimate with the subject—that to produce with pure black lines the quality and effect of lines in which there is some gradation of tone, is no easy matter, especially to those accustomed to the wood engraver as the interpreter of their work. Sir John Tenniel, Mr. Du Maurier, and Mr. Sambourne, not to mention others on the *Punch* staff, have been accustomed for many years to draw for wood engraving, and would probably still prefer this method to any other.

But the young illustrator has to learn the newer methods, and how to get his effects through direct photo engraving. What may be done by the latter is sufficiently demonstrated in the line drawings which appear in our newspapers, magazines, and books; I speak of those which are well printed and on good paper. Many German and French periodicals teach us what to admire and what to avoid. I am referring only to line drawing in this first lecture, because it is the only process in relief which may be said to give any certain results, leaving the consideration of other developments of process work until next week. Line drawings are now reproduced on zinc blocks fitted for the type press at a cost of less than sixpence the square inch for large blocks. The first condition for this process is to draw in pure black lines on Bristol board, or smooth white paper; the process of reproduction will be explained further on.

Let us glance first at the ordinary hand-book teaching, and see how far it is useful to the illustrator of to-day. The rules laid down as to the methods of line work, the direction of lines for the expression of certain textures, "cross hatching," etc., are, if followed too closely, apt to lead to hardness and mannerism in the young artist, which he will with difficulty shake off. On these points, Mr. Robertson,* the well known painter and etcher, writing seven years ago, says well:

"The mental properties of every line drawn with pen and ink should be original and personal; . . . this strong point is sure to be attained unconsciously, if an artist's work is simple and sincere, and *not the imitation of another man's style.*"

"When the question arises as to what examples a beginner should copy who wishes to practice the art of pen and ink drawing, the difficulty will be to select from the great and varied stores of material that are everywhere to his hand. All steel and copper plate engravings that have been executed in line, and all wood engravings, are within the possible range of pen and ink drawing. I hold, however, that much time should not be occupied in the imitative copying of prints; only, indeed, so much as enables the student to learn with what arrangement of lines the different textures and qualities of objects may be best rendered."

There are, roughly, two methods of obtaining effect with a pen—one by few lines, laid slowly; and the other by many lines, drawn with rapidity. If the intention is to see what effect may be obtained with comparatively few lines deliberately drawn, we may refer to the woodcuts after Albert Durer and Holbein and the line engraving of Marc Antonio. The engraved plates by Durer furnish excellent examples of work, with more and finer lines than his woodcuts. "Some of the etchings of Rembrandt are examples of what may fairly be reproduced in pen and ink, but in them we fiud the effect to depend upon innumerable lines in all directions. In the matter of landscape the etched plates by Claude and Ruysdael are good examples for study, and in animal life we may refer to those of Paul Potter and Dujardin."

Thus, for style, for mastery of effect and management of line, we must go back to the old masters, to work produced generally in a reposeful life, to which the younger generation are strangers. But the mere copying of other men's lines is of little avail without mastering the principles of the art of line drawing. The skillful copies, the *facsimiles* of engravings and etchings drawn in pen and ink, which are the admiration of the young artist's friends are of little or no value in deciding the aptitude of the student. The following words are worth placing on the walls of every art school: "Proficiency in copying engravings in *facsimile*, far from suggesting promise of distinction in the profession of art, plainly *marks a tendency to mechanical pursuits*, and is not likely to be acquired by any one with much distinctive feeling for the arts of design."

There is much truth and insight in this remark.

In line work, as now understood, we are going back in a measure to the point of view of the missal writer and the illuminator, who, with no thought of the possibilities of reproduction, produced many of his decorative pages by management of line alone (I am speaking of the parts of his work in which color was not employed). No amount of patience, thought, and labor was spared for this one copy. What would he have said if told that in centuries to come this line work would be revived in its integrity, with the possibility of the artist's own lines being reproduced 100,000 times, at the rate of several thousand an hour? And what would he have thought if told that out of thousands of students in centuries to come, a few, a very few only, could produce a decorative page; and that few could be brought to realize that a work which was to be repeated, say a thousand times, was worthy as much attention as his ancestors gave to a single copy?

On the principle that "everything that is worth doing is worth doing well" and on the assumption that the processes in common use—I purposely omit mention of the olden systems of drawing on transfer paper, and drawing on waxed plates, without the aid of photography; also of photo-lithography: these have been dealt with in previous papers—are worth all the care and artistic knowledge which can be bestowed upon them, we would press upon young artists especially the importance of study and experiment in this direction. As there is no question that "the handwork of the artist" can be seen more clearly through mechanical engraving than through wood engraving, it behooves him to do his best. And as we are substituting process blocks for wood engraving in every direction, so we should take over some of the patience and care which were formerly given to book illustrations.

We cannot live, easily, in the cloistered silence of the past, but we can emulate the deliberate and thoughtful work of Mantegna, of Holbein, of Albert Durer, and the great men of the past, who, if they were alive to-day, would undoubtedly have preferred drawing for process to the labor of etching and engraving; and, if their work was to be reproduced by others, they would have perceived, what it does not require much insight in us to realize, that the individuality of the artist is better preserved by making his own lines than by those of the engraver. To do this successfully in these days, the artist must give his best and most deliberate (instead of his hurried and careless) drawings to the processes; founding his style, to a limited extent, it may be on the work of the old engravers, but preserving his own individuality.

But we must not slavishly copy sketches by the old masters, which were never intended for reproduction. We may learn from the study of them the power of line to express character, action, and effect, we may learn composition sometimes, but not often, in a sketch.

As to copying the work of living artists, it should be remembered that the manner and the method of a line drawing is each artist's property, and the repetition of it by others is injurious to him. It would be an easy method indeed if the young artist, fresh from the schools, could, in a few weeks, imitate the mannerism, say of Sir John Gilbert, whose style is founded upon the labor of fifty years. There is no such royal road.

But for the illustrator by profession there seems no artistic leisure in 1893, no time to do anything properly in this connection.

"It is a poor career, Blackburn," said a well known newspaper illustrator to me lately (an artist of distinction and success in his profession, who has practiced it for twenty years); "you seldom give satisfaction—not even to yourself."

"It is an *ideal career*," says another, a younger man, who is content with the more slapdash methods in vogue to-day, and with the income he receives for them.

There is another point to notice. The education of the illustrator in these days means much more than mere art training. The tendency of editors of magazines and newspapers is to employ those who can write as well as draw. This may not be a very hopeful sign from an art point of view, but it is a condition of things which we have to face.

In sketches of society the education and standing of the artist has much to do with his success. Mr. Du Maurier's work in *Punch* may be taken as an example of what I mean, combining excellent art with knowledge of society. His clever followers and imitators lack something which cannot be learned in an art school.

Much as we may desire to see a good artist and a good *raconteur* in one man, the combination will always be rare; and those editors who seek for it are often tempted to accept inferior art for the sake of the story. I mention this as one of the influences affecting the quality of illustrations of an ephemeral or topical kind, which should not be overlooked.

It should be borne in mind that, in drawing for reproduction by any of the mechanical processes (either in wash or in line, but especially the latter), there is more strain on the artist than when his work was engraved on wood, and the knowledge of this has left process drawing principally in the hands of the younger men. They will be older by the end of the century, but not as old then as some of our best and experienced illustrators who keep to wood engraving.

I am touching now upon a difficult and delicate part of the subject, and must endeavor to make my meaning clear. The illustrations in *Punch* have, until lately, all been engraved on wood (the elder artists on the staff not taking kindly to the processes), and the style and manner of line we see in its pages is due in great measure to the influence of the wood engraver.*

This refers to *facsimile* work, but the engraver, as we know, also interprets wash into clean lines, helps out the timid and often unsteady draughtsman, and in little matters puts his drawing right.

Now the wood engraver was apprenticed to, his art, and after long and laborious teaching, mastered the mechanical difficulties. If he had the artistic sense he soon developed into a master engraver and illustrator, and from crude and often weak and inartistic drawings he produced illustrations full of tone, quality and beauty. (He does so still, to a limited extent, as many an author knows.)

From very slight material handed to him from a publisher the wood engraver would evolve (from his inner consciousness so to speak) an elaborate and graceful series of illustrations, drawn on the wood block by artists in his own employ, who had special training, and knew exactly how to produce the effects required. The system often involved much care and research for details of costume, architecture and the like, and, if not very high art, was at least well paid for, and appreciated by the public. I am speaking of the average illustrated book say of twenty years ago, when it was not an uncommon thing to spend £500 or £600 on the engravings of a book. Let us hope that the highest kind of wood engraving will always find a home in England.

I do not think the modern illustrator realizes how much depends upon him in taking the place, so to speak, of the wood engraver. But the interpreting of tone into line fitted for the type press, to which the wood engraver gave a lifetime, will devolve more and more upon him. We cannot keep this too continually in mind, for, in spite of the limitations in mechanically produced blocks (as compared with wood engraving) in obta ning delicate effects of tone in line, much can be done in this direction in which the engraver has no part. That it is possible, by the common processes, to obtain effects almost equal to wood engraving, may be seen in the illustrations to Mr. Andrew Lang's

* There seems but one rule of criticism in this connection. If a book illustration comes out coarsely and (as is often the case) almere smudge, the process is blamed, when the drawing or photograph may have been quite unsuitable for the process employed.

* "The Art of Pen and Ink Drawing," by H. R. Robertson. London: Winsor & Newton, 1886.

* One of the most accomplished of Englisb painters told me the otber day that when he first drew for illustration, the wood engraver dictated the angle and style of cross hatching, etc., so as to fit the engravers' tools.

"Blue Poetry Book," by Mr. Lancelot Speed, in which many technical experiments have been made, including the free use of white lining by process.* But more notably, from an art point of view, are the Illustrations, produced lately at the Birmingham Municipal School of Art, by process drawing, one of which I will show you on the screen.

All this, you will observe, points to a higher use of the process block than is generally allowed, to something, in short, very differe t to the thin sketchy outlines and scribbles which are considered the proper functions of the "pen and ink artist."

But "the values" are scarcely ever considered in this connection. Mr. Hamerton makes a curious error in his "Graphic Arts," where he advocates the use of the "black blot in pen drawing," arguing that as we use liberally white paper to express air and various degrees of light, so we may use masses of solid black to represent many gradations of darkness. A little reflection will convince any one that this is no argument at all.

The ideal illustration by mechanical means is, where the principles of line engraving are followed to the utmost limits of pen and ink drawing, where the lines of the drawing do not intrude upon the effect—a drawing which can be reproduced with the least touching or "rouletting" on the block, and which requires the least "overlaying" and "making ready" on the part of the printer.

Mr. Ruskin's advice, in his "Elements of Drawing," as to how to lay flat tints by means of pure black lines (although written many years ago, and before mechanical processes of reproduction were in vogue) is singularly applicable and useful to the student of today, especially where he reminds him that, "if you cannot gradate well with pure black lines, you will never do so with pale ones."

To "gradate well with pure black lines" is, so to speak, the whole art and mystery of drawing for the photo-zinc process, of which one London firm alone turns out more than a thousand blocks a week.

As to the amount of reduction that a drawing will bear with advantage in reproduction it cannot be sufficiently widely known, that in spite of rules laid down, there is no rule about it.

Mr. Emery Walker, of the firm of Walker & Boutall, who has had great experience in the reproduction of illustrations and designs from the old books and manuscripts, will tell you that very often there is no reduction of the original; and he will show reproductions in photo-relief of engravings and drawings of the same size as the originals, the character of the paper, and the color of the printing also, so closely imitated, that experts can hardly distinguish one from the other.

On the other hand the value of reduction, for certain styles of drawing especially, can hardly be overestimated. On these walls you may see drawings reduced to one-sixteenth the area of the original, some even more, and results obtained which could be achieved by no other means

Again I say "there is no rule about it." In the course of years, and in the reduction to various scales of thousands of drawings by different artists, to print at the type press, my experience is that *every drawing has its scale, to which it is best reduced.*

A word as to sketching in line from life ready for reproduction on a process block. The system is, I know, followed by a few illustrators for newspapers (whose names might easily be mentioned), who by incessant practice have become proficient. They have special ability for this kind of work, and their manner and style is their capital and attraction.

But to attempt to teach rapid sketching in pen and ink is beginning at the wrong end, and is fatal to good art; it is like teaching the principles of pyrotechnics while fireworks are going off. And yet we hear of prizes given for rapid sketches to be reproduced by the processes. Indeed, I believe that is the wrong road; the baneful result of living in high pressure times. Imagine any artist of the past—you might almost say any artist of the present—consenting to such a system of education. †

Sketching from life is, of course, necessary to the student, but it should be done in pencil or whatever medium is easiest at the moment; but the lines for reproduction require thinking about, thinking what to leave out and how to interpret the gray of a pencil, or the tints of a brush sketch in the fewest lines. Thus, and thus only, the student learns the art of leaving out, "the value of a line."

The tendency of modern illustrators is to imitate somebody; and in line drawing for the processes, where the artist, and not the engraver, has to make the lines, imitation of some man's method is almost inevitable.

Let me quote an instance. The style of the late Charles Keene is imitated in more than one journal at the present time, the artists catching his method of line more easily than the higher qualities of his art, his *chiaroscuro*, his sense of values and atmospheric effect. I say nothing of his pictorial sense and humor, for they are beyond imitation. It is the husk only we have presented to us.

As a matter of education and outlook for the younger generation of illustrators, this imitation of other men's lines deserves our special consideration. Nothing is easier in line work than to copy from the daily press.

## THE BOILING OF LINSEED OIL. ‡

WHEN raw linseed oil is heated to from 450 to 500° F, with a small addition of litharge, red lead, manganese or some other metallic salt, which by catalytic action can set up oxidation in the oil, it becomes heavier, dries up more quickly, and leaves behind a coating which is of a more highly lustrous character than is the coating from raw linseed oil. On these phenomena is based the production of what is known as "boiled" linseed oil. The process of boiling may be carried out in two ways—the first or oldest method is by direct fire heat in iron boilers, the second or newest process is by means of steam heat in suitably constructed boilers. In no case is the process at all a difficult one, and yet care must be exercised if a satisfactory result is to be obtained.

*Boiling by Direct Fire Heat.*—This is carried out in an iron boiler made like a common wash house boiler, or, better still, of boiler plate with cylindrical sides and a hollow bottom riveted on the sides, as the bottom is the part which is usually worn away long before the sides are, this method of construction affording an easy way of repairing by putting new bottoms when required. The boiler is set in brick work, so that the fire comes only in contact with the bottom of the boiler; a flue running round the lower third of the boiler serving to carry the heat in an efficient manner to the contents of the boiler. The boiler should be built against the outer wall of the oil-boiling shop, so that the fireplace is fed from the outside, this precaution being necessary for the purpose of avoiding fires. Oil has sometimes a nasty trick of boiling over in an unexpected fashion, and if the fireplace is inside, the oil would be likely to find its way into it, with the result that a fire would occur. The boiler should have a capacity at least twice as great as the quantity of oil it is desired to boil in it. Above the boiler ought to be fixed a ventilating hood to carry off any fumes which may be produced, and which, if allowed to accumulate in the boiling shed, would inconvenience the workmen.

The oil to be boiled is run into the boiler until the latter is about half full, the fire is lighted, and the oil slowly heated. It should be closely watched, because it is in this preliminary heating where the greatest risk of boiling over occurs. Should this happen, the fire must be drawn immediately, and the oil quickly ladled out into another boiler, where it is kept until it has got cold, when it can be restored to the boiler, and the fire again started. A thermometer placed in the oil is washed and the firing regulated so that the heat does not exceed 590 F. There is no advantage to be gained in heating above this, while further there is the disadvantage of the oil becoming charred and thereby discolored. After being kept about two hours at this heat, during which time any water which the oil may contain will have been driven off, the driers are added in small quantities at a time in proportions according to the use to which the resulting boiled oil is to be put. Of litharge about 5 lb. are required for a ton of oil, of red lead about the same amount, of manganese half these quantities are sufficient for an ordinary boiled oil for painters' use, while for making oilcloths or linoleum larger quantities are added The addition of the litharge should extend over a period of two to three hours, the oil being stirred up from time to time during the interval; after the whole of the drier has been added, the boiling should be continued for at least two hours longer, although for a quick-drying heavy-bodied oil three or four hours' boiling may be given with advantage. At the end of that time the fire is drawn and the oil left to cool down, after which it is run into storage tanks to settle, the clear oil is drawn off for use, while the turbid "foots" is run off for other purposes.

*Steam Boiling.*—This method of producing boiled oil was introduced by C. W. Vincent, and has become largely used, it giving, as a rule, a paler oi. than can be obtained by the fire process. It is carried out in a steam-jacketed iron or copper pan; arrangements are provided for agitating the oil during the operation, while a current of air can be sent into the oil during the operation. Into the pan is put the oil; the steam, which is used at a pressure of about 40 lb., is sent into the jacket and the oil heated until a peculiar sickly smell is evolved, the agitator being at work the whole of the time. A small quantity of driers is now added; these are preferably some compound of manganese. The borate is the best, although Hartley recommends using the linoleate, and air is blown through the oil. From time to time more driers are added until the required quantity has been used, the working is carried on for four hours longer, when it is ended and the oil is run off into the storage tanks to settle and clarify.

When lead is used as a drier, some of it passes into the oil in the form of lead linoleate, while some free linoleic acid is formed and acrolein evolved. The lead linoleate imparts to the oil the property of drying with a glossy coating; at the same time it prevents the oil from being used with some bright pigments like cadmium yellow, ultramarine, vermilion, and antimony orange, which contain sulphur, without some risk of their becoming discolored. When used for bright colors in towns the sulphur which is usually present reacts with the lead which is in the oil, causing them to become of a brownish hue. Boiled oil which contains lead when exposed to the air gradually becomes brown. These are some disadvantages which attach to the employment of lead-boiled oil.

When manganese is used as the drier, this also forms manganese linoleate, which passes into the oil, but does not impart to it any property of becoming discolored by use in any way; it may therefore be employed with all pigments without fear of any deterioration of beauty of tint. Then, again, there is considerably more oxidation of the oil with a manganese drier than there is when litharge has been used, so that a manganese boiled oil dries much quicker than a litharge boiled oil.

*Hartley & Blenkinsop's Process.*—A new process for making a very pale boiled oil has been devised by Messrs Hartley & Blenkinsop. This consists in first treating the oil with dilute sulphuric acid; an acid containing about 30 per cent. of actual sulphuric acid is the best to use, as at this strength it dehydrates the oil, but does not carbonize it at all. After standing to allow the oil and acid to separate, the clear oil is drawn off and is ready for the next process. This consists in treating the oil with a solution of manganese linoleate in some hydrocarbon spirit. Care is taken in not adding too much of this material. It exerts a bleaching action on the oil, which becomes a very pale color, but if too much is added then further oxidation of the oil may occur, and this is not desirable. Air is blown into the oil at the same time. This materially assists in the bleaching and accelerates it considerably. By heating to about 260° F., adding just enough manganese linoleate and blowing air through the oil, the latter becomes bleached and then decomposed as in the ordinary boiling process, increases in density, acquires drying properties, while the color is quite pale. The oil so prepared is excellent for use as a paint oil, dries well and rapidly, and can be mixed with all pigments without leading to any discoloration whatever. Whites retain their purity of tone unchanged, a feature of no small advantage.

## BLEACHING OILS.*

THE class of oils which we have in view at the present moment are the fatty oils which are obtained from animal or vegetable sources; frequently these are more or less colored, which coloration is caused by a variety of circumstances. In the case of vegetable oils, sometimes the material from which they are expressed contains a peculiar coloring matter—this is the case with cotton oil; then again there are nearly always small quantities of the peculiar vegetable coloring matter, chlorophyl, present in one or other of its forms, as is notably the case with the green olive oils. Palm oil, again, is notable on account of its containing a bright orange coloring matter to which it owes its characteristic color. In the case of animal oils, the quality of the material has some considerable influence on the color, while, further, the oil may lick up something from the apparatus or plant in which it is being treated. This discoloration of the oil has to be removed before the oil is fit for use for many purposes, although there are others for which the colored oil may be used without any treatment whatever.

Bleaching oils is a very difficult thing to do, especially on the small scale. So many and varied are the conditions which conduce to the success of the operation that very often a process which works well with one fat or oil will fail with another, and a ton of oil can be bleached by one method, and yet the same method fails with a hundredweight of the oil. As to laboratory experiments on bleaching, they are very rarely successful.

The great difficulty in bleaching oils arises from the trouble there is in making a thorough admixture of the oil with the bleaching agent which is being used, and also of exactly proportioning the amount of the latter to the oil; for if too great an excess be used, it often happens that the oil becomes colored by it to a greater extent than at first, and the remedy then becomes worse than the disease.

### THE AIR AND CHARCOAL PROCESS.

Probably the very best general process for the bleaching of oils is to take advantage of the bleaching property of a current of air combined with that of animal charcoal. To do this in the best possible manner the following process may be adopted. First of all, the oil is heated to about 100° F. and then mixed with weak sulphuric acid, made by mixing one gallon of ordinary strong sulphuric acid with two gallons of water, using four gallons of this weak acid for every 100 gallons of oil. The mixture is well stirred together, and then heated to about 180° F., when it is allowed to cool down. After cooling the acid will be found to have settled at the bottom and the oil will be freed from any animal or vegetable matter and moisture by this process, while the oil itself will be but little affected. The next proceeding is to separate the acid from the oil, which may be done in any convenient manner. A current of air is then blown through the oil by means of a pump or fan as is most convenient. The blowing should not occupy more than two hours. Next a tall cylindrical boiler placed on end is filled with dry animal charcoal, the pieces of which should not be too small. Lumps about the size of a pea are best. At the upper end of the boiler is a manhole for feeding, while at the bottom is a hole for running off the clarified oil. The oil treated as above described is now run through this boiler, the contents of which work best if heated to about 100 to 120° F. Possibly a single passage through the charcoal may not effect the desired amount of bleaching, but a repetition of the passage will assuredly do so. One advantage of this method is that the oil is not injuriously affected by the use of chemicals, and it is clarified from any solid matter it may contain in suspension. One disadvantage is that the charcoal retains a large proportion of the oil, which, however, is practically recovered in subsequent batches. The charcoal will serve to treat a large quantity of oil, and should it lose its bleaching properties, they may be restored by first extracting the oil it contains by means of benzoline or some such solvent, then heating the charcoal to redness in a closed retort.

### THE SULPHUROUS ACID PROCESS.

A very good plan of bleaching oils, which may be adopted more especially with the green olive oils, is first to treat them with weak sulphuric acid as directed above, then to blow air into them which has been passed through liquefied sulphurous acid gas for some time, until the oil has become sufficiently decolorized. It is then washed with warm water to free it from sulphurous acid, the water allowed to settle, and the clear oil used.

This process may be modified as follows: The oil is treated with weak sulphuric acid, and then, after separating the oil and acid, the former is run into a tank with from four to five gallons of liquid bisulphite of soda for every hundred gallons of oil being treated; air is then blown through the mass, the oxygen of which, along with the sulphur dioxide liberated from the bisulphite, effecting the bleaching of the oil.

The introduction of peroxide of sodium, which is chiefly made by the Aluminum Company at Oldbury, has placed a new bleaching agent at the command of the oil bleacher which will be found very serviceable in many cases. This product cannot, however, be used directly, or it would simply bring about the saponification of the oil, which is not desired. To use this product the peroxide of sodium should be mixed with about three times its weight of magnesium sulphate (Epsom salts). It must be kept in tight cases of metal or in bottles. From one to one and a half pounds of peroxide of sodium will be required per 100 lb. of oil. The mixture of peroxide and Epsom salts is mixed with water, and this is then added to the oil, the whole being warmed to about 130° F. and thoroughly agitated together for some time, then it is allowed to stand for the oil and aqueous liquor to separate, when the oil can be drawn off. As a general rule the oil will be found to be bleached sufficiently, a repetition of the process only as a rule being necessary when very dark oils are being treated.

* *Chemical Trade Journal.*

* Mr. Robertson's hand book is here a little out of date, where he says: "Wood cuts in which white lines play a prominent part are obviously unsuited as examples or suggestions for pen and ink work;" but white lines, drawn with pen or brush, are continually used in process work.

† Mr. Joseph Pennell's wonderful pen and ink drawings from the towers of Notre Dame are the exception which prove the rule.

‡ *Chemical Trade Journal.*

## COTTONSEED OIL RUBBER.

By C. B. Warrand.

Products from drying vegetable oils having been employed for many years as substitutes for rubber or caoutchouc, a description of their employment in the past will probably be of some interest to our readers, as it strongly indicates the adaptability of cottonseed oil as one of the best substitutes for rubber, if rubber obtained from same is not an artificial rubber.

If linseed oil, for instance, be brought to a thick glue-like consistency by boiling for at least twenty-four hours, and dilute nitric acid be added and the boiling be continued for several hours longer, the linseed oil will be changed to a plastic mass, which will become hard on exposure to the air. On dipping this mass in hot water it regains its softness, and on cooling it hardens again. This product is the caoutchouc or rubber of drying vegetable oil, which can be produced from any vegetable drying oil, but less economically than from linseed oil.

Nitric acid is one of the best oxidizing agents, and the production of this oil caoutchouc is evidently a result of the oxidation of the linseed oil. Just in the same way cottonseed oil can be oxidized and will form a rubber or caoutchouc, although different means have to be used for the effective oxidation of cottonseed oil, as it is not strictly a drying oil, but it is an intermediate between drying and non-drying oils.

This oil caoutchouc is of considerable commercial importance, as it forms the basis of a great number of industrial products. If linseed caoutchouc is mixed with litharge, it is excellently adapted to the manufacture of bougies, catheters, flexible sounds, and many other surgical instruments, and it has been used for this purpose for many years.

The oil caoutchouc can also be readily vulcanized by chloride of sulphur dissolved in benzine or carbon disulphide, with or without the admixture of magnesia, lime or baryta, or various lead, copper, zinc, or antimony oxides. It is also largely used in the manufacture of linoleum or oil cloth; it also makes a very good waterproof material, if a small quantity of natural rubber is added. Linseed oil consists of a mixture of linolein, the glyceride of linoleic acid; about 80 per cent. of the same consists of olein, palmitin, and myristin.

The well-known quality of linseed oil as a varnish is increased by boiling with such mineral substances as are capable of yielding a portion of their oxygen to the oil, thus causing a partial oxidation of the oil. For this purpose plumbic oxide (litharge), red lead, and anhydrous linoxide of magnesia are employed. The last two are used conjointly, and to these oxidizing agents have been added lead oxides, plumbic acetate, zinc sulphate, etc.

By boiling not only does a partial oxidation take place, but by increasing the temperature to between 600° and 700° the mucilage and other impurities of the oil are driven off as a yellow froth, or they are removed by partial destructive distillation.

The partial oxidation which occurs by thus boiling linseed oil is finished when thin coats of this varnish are exposed to the air and sunlight, forming a complete coat of oil caoutchouc; hence the unsurpassed value of linseed oil as the basis of the best known varnishes.

Cottonseed oil consists of 30 to 34 per cent. of palmitin and 66 to 70 per cent. of olein; hence it is quite probable that it can be used the same as linseed oil, as in both the predominant part is olein. That it has to be treated differently from linseed oil to obtain the same results is also likely. The palmitin commences to harden at 55° F., and is completely congealed at 32°, while the oil or olein does not congeal above 28°; hence it is an easy matter to separate the palmitin, which is, however, better known as the stearine of commerce, by simply reducing the temperature of the crude oil to 23° F., and expressing the oil in a filter press. This stearine is largely used in the manufacture of refined lard, and while a pound of crude oil is now worth about five cents, the crude stearine is worth some eight or nine cents per pound.

After separating the palmitin the oil has to be refined and bleached before it can be used for culinary purposes or for the manufacture of numberless artificial butter products, called butterine, oleomargarine, etc. This is usually accomplished by the use of carbonate or caustic alkalies and sulphuric acid. Such a treatment of the oil, however, seems to cause some change in the oil which renders it incapable of further oxidation. By long exposure to the air and sunlight this refined oil does not thicken and oxidize, but it becomes rancid and acrid; hence experiments to produce rubber from refined oil of commerce will always fail, while it is comparatively an easy matter to oxidize crude cottonseed oil deprived of its stearine.

Some five or six years ago an English inventor sold to an American rubber manufacturer for a considerable amount a secret process for manufacturing cottonseed oil into rubber. Since then this secret has become the property of the rubber trust. This process has been used ever since, and it is a matter of fact that large quantities of cottonseed oil are now being used by at least fifteen or sixteen rubber factories in the United States to produce a substitute for rubber. This is in the United States alone. I do not know to what extent this process is being used in England and on the Continent, but as it originated in England, it is probably used to some extent there also.

By this process the converted cottonseed oil costs about seven cents per pound. The admixture of this substitute has been limited to about 15 per cent., as it is not deemed advisable to exceed this amount without deteriorating the quality of the rubber product.

The specific gravity of crude cottonseed oil is 0·93; if the palmitin is removed, the gravity of the remaining oil is lowered to 0·921. By boiling the oil for some time the impurities are removed and the specific gravity is lowered a little more; but by my experiments the specific gravity increases as the oxidation of the oil proceeds. What I considered perfectly oxidized oil or finished rubber has a gravity of 0·925, which is identically the same as that of pure rubber.

There is no known way to ascertain the quantity of pure rubber employed in finished products by the way of a chemical analysis. The only known way to approximate the purity of finished rubber products is by the specific gravity of the same. Hence a substitute which has the same specific gravity, the same elasticity, the same faculty to vulcanize, is a very valuable substitute, if it is not of identically the same chemical composition.

Rubber is composed of nine atoms of carbon and seven of hydrogen. It is, however, quite probable that there is a more complex mixture of various hydrocarbons, which have, so far, not been ascertained.

The composition of olein is eighteen atoms of carbon, thirty-four atoms of hydrogen and two atoms of oxygen. This formula divided by two would give nine atoms of carbon, the same as rubber, seventeen atoms of hydrogen and one atom of oxygen. Assuming that ten atoms of hydrogen were combined with the atom of oxygen and other oxygen from some other source—from the atmospheric air, for instance, by heat, sunlight or electricity, or from some oxidizing agent like ozone—the result would be chemically pure rubber and water, which would evaporate.—*Chem. Tr. Jour.*

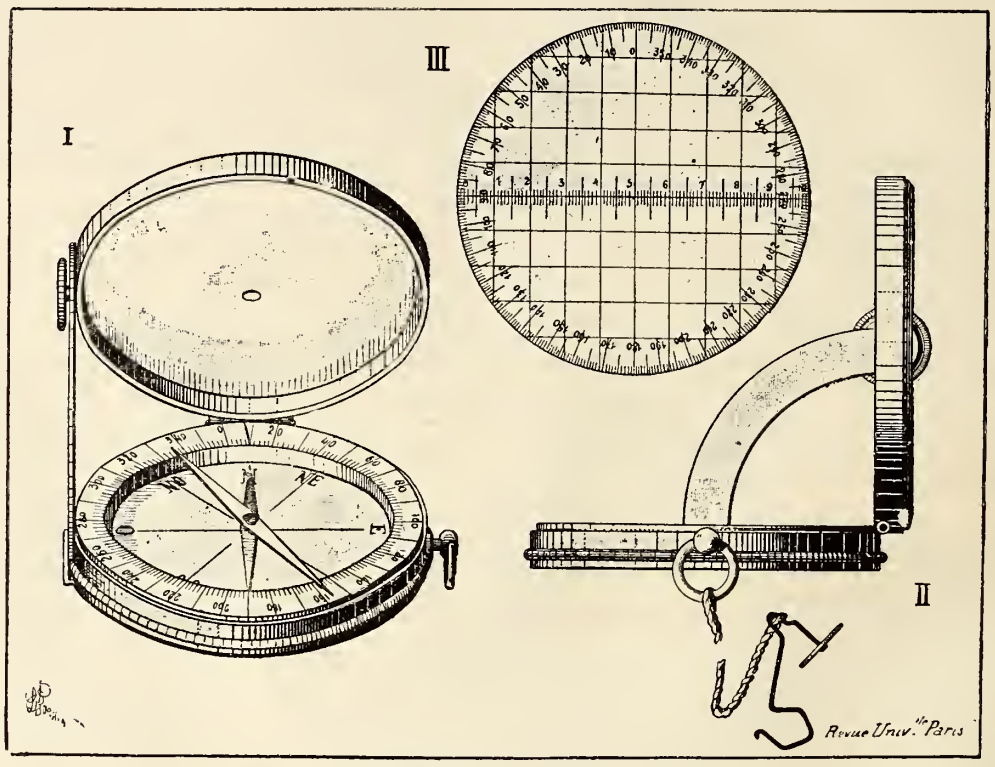



Fig. 1.—PANTOMETRIC COMPASS GUIDE.

I. Interior view of the compass. II. Elevation of the box, open. III. Azimuthal protractor.

## PANTOMETRIC GUIDE COMPASS.

This compass, according to its inventor, is designed especially for army officers, but may also be usefully employed by explorers, tourists, bicyclists, etc. It differs from ordinary pocket compasses in that, by a very simple process, it gives the geographic north and the magnetic north, whatever be the declination of the place in which the observer chances to be, and consequently permits of automatically solving, by means of what is called an azimuthal protractor, all the important problems of the map with precision and with great rapidity. It may, besides, serve as a sun dial.

As shown in the figure, it consists of a box containing a graduated limb capable of revolving with hard friction around the axis of the compass through the aid of a rod that is introduced successively into apertures formed in the side of the box. It is closed by a mirror cover divided in two by a line that determines the axis of the compass, and is provided with an aperture for sighting.

The bottom of the box also is divided in two by a line that likewise determines the axis of the compass. This line and that of the mirror constitutes the plane of the sighting. A graduated dial fixed upon the left side permits giving the cover any inclination whatever. A binding screw keeps the cover in such position. The compass is completed by a false needle that revolves freely over the glass, and by a reference point placed in the axis of the compass. A copper support provided with an aperture for the passage of a copper point permits of fixing it upon any piece of wood whatever. Finally, from the side of the box hangs a chain carrying a copper rod that serves to revolve the graduated limb as well as the style of the sun dial.

The azimuthal protractor measures the angles with respect to a fixed direction—the geographical meridian. It is provided with a cross-ruled disk that is applied to the map in such a way that its lines shall be parallel respectively with the parallels and meridians. It is of sufficient size to permit the cross ruling to always cover one of these lines.

It is graduated upon the sides in such a way that if the two faces be supposed to be turned down upon the same plane (as shown in the figure), we shall have a complete division of the circle into 360°, the north part comprising the divisions from 0° to 90° and from 270° to 360°, and the south part those from 90° to 270°. The rectilinear side of the protractor is graduated into centimeters and millimeters and serves as a rule.

Before using the compass it is necessary to decline it, this being easily done in one of the following ways: (1) by means of the map; (2) by the process of corresponding heights; and (3) by means of the pole star, of the sun, of the passage of the stars at the meridian, or of the sun and a watch.

The principal problems that the apparatus permits of solving are: (1) the exact determination upon the map of the point at which one is situated; (2) knowing such point, the exact determination of the direction of the points invisible upon the ground; (3) the tracing of the direction to be taken in order to go from the point at which one is situated to any other, visible or invisible; (4) the determination of any angle whatever with a given direction; (5) the operations of rapid surveying, planimetry, leveling, determination of distances, etc.

For all such operations it is preferable to fix the compass upon a support rather than to hold it in the hand.

Fig. 2.—INSTALLATION OF THE PANTOMETRIC COMPASS GUIDE FOR OBSERVATION.

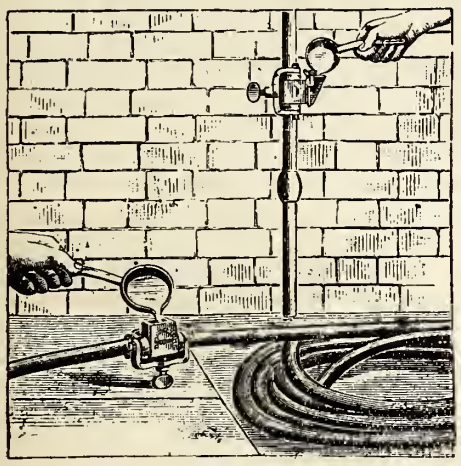
The support may consist of a simple stick of wood sufficiently rigid and firmly implanted in the earth. The compass is held in place by means of the support that we have already mentioned, and that is capable of revolving in all directions around a copper point inserted in the wood.

The mirror raised vertically, and the eye so reflected that it is divided in two by the vertical line, determine a very satisfactory sighting plane.

The sighting may also be done by placing the mirror at any inclination and putting the line of the bottom of the compass in concordance with the line of the mirror. These two lines determine the sighting plane. The object sighted should appear exactly in the center of the aperture—an operation very easy for the eye and of great precision.—*Les Inventions Nouvelles.*

## NEW PIPE JOINT.

A NEW kind of joint for all kinds of plumbing, but especially chemical plumbing, has recently been introduced by the Portable Oil Furnace Company, Limited, of Nottingham, which can be made by means of their new patent tie-joint moulds. These moulds are something new to the plumbing world, as they claim to make plumbing joints with either lead or solder without obstructing the waterway, or using brass tube for the inside of the lead pipe. This has been wanting for some time, especially in the case of chemical works, as ordinary solder is practically useless in such cases. The tie-joint mould entirely does away with all old difficulties, such as weeping and sweating of joints, through the solder being porous, as lead is the material used. Every joint is guaranteed to stand a pressure of 600 pounds per square inch. The joints are made proportionate in strength to the size of the pipe.



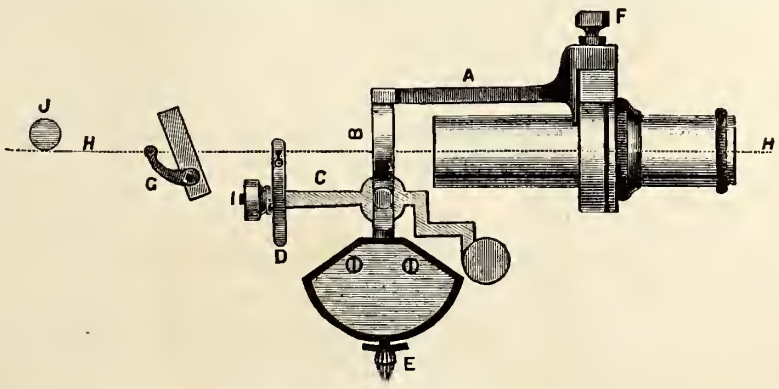
The cost is also another noteworthy feature, as these moulds make better joints with old lead worth about one penny per pound than can be made by the old method of "wiping" with solder costing about seven pence a pound.—*Chem. Tr. Jour.*

## THE ANGLEOMETER.

THE instrument shown takes the form of a very simple attachment for the sextant or quadrant, devised by Captain James B. Murray, of Glasgow, to determine and maintain the horizontal plane of the observer's line of sight, making it now possible for navigators to obtain reliable altitudes of celestial objects at sea without a horizon of any kind, and is quite independent of the height of observer's eye above the sea level. The device consists of an attachment secured to the telescope holder by a thumb-screw, as shown below. It consists of a balanced fork with a fine wire at right angles to the plane of the sextant. This fork has a vertical slot on the lower part, and is attached to one end of a horizontal lever by means of a binding screw, capable of vertical and circular adjustment; this is counterbalanced by a small disk at the opposite terminal. This lever is fulcrumed at its center of gravity by platinoid center points working in platinoid concave sockets. A vertical box balance, containing liquid, is attached to this lever at its center of gravity, and will always hang truly vertical when free. The lever with fork and fine wire being fixed at right angles to the vertical balance will always be truly horizontal when the vertical balance is allowed to assume its natural position. A fine wire is fitted to the ends of the horizon glass frame by two adjustable arms, and is adjusted truly horizontal or at right angles to the plane of the sextant, and exactly bisecting in a horizontal plane the line of sight through the telescope. The fixed wire, above referred to, can be fitted in a special telescope instead of being placed on horizon glass frame, at shown in the above illustration. The telescope is fitted with an adjustable horizontal wire at one end, bisecting the line of sight, and having an adjustable sight at the other end for adjusting the same to suit the observer.

Referring to the illustration, A is the horizontal bar, B the vertical complement, C the horizontal balance, D the slotted fork with horizontal wire, E the thumb-screw for securing the device, F the binding and vertical adjustment screw, G the adjustable arms with horizontal wire, H the line of sight through the telescope, I the binding screw on horizontal balance, and J the sun's lower limb on horizontal plane.

The great importance of this useful instrument to masters who have valuable lives and property under their care cannot be overestimated. It will be found especially valuable to all masters engaged in the North Atlantic and St. Lawrence trades, when dense fogs are prevalent during the summer months, while the sun, moon, and stars are often plainly visible overhead, but hitherto practically useless to the navigator, except for azimuths. This instrument, under such circumstances, would be the means of relieving masters from doubt and anxiety, while it secures the safety of the vessel when the sea horizon is unreliable or completely obscured by fog. A little steady practice at first in the use of this instrument is all that is necessary to establish perfect confidence in the results. It is claimed for the angleometer that it has the decided advantage of being simple and efficient and perfectly reliable when properly used, easily adjusted when necessary, always ready for use, and does not interfere with observations being taken to the sea horizon, although attached to the sextant, where it can remain while that instrument is in the box. Several of these instruments have lately been subjected to a thorough practical test in vessels employed in the St. Lawrence trade, where thick, foggy weather predominates, and the results were found to be highly satisfactory, perfect confidence in the instrument being established after a little practice. The only objection found in practice was the difficulty of holding the sextant sufficiently steady under circumstances of excessive vibration, etc., but, as a result of a series of experimental trials, this difficulty has now been completely overcome by causing the vertical balance to work inside of a fixed quadrant-shaped box containing a specially prepared oil.—*The Steamship.*




MURRAY'S ANGLEOMETER.

## THE MANUFACTURE OF FIREWORKS IN FRANCE.*

THE decorative pieces that we shall speak of further along are provided with port fires, a species of blue lights inclosed in paper cases from 8 to 10 millimeters in diameter by 8 to 12 centimeters in length.

When a display of fireworks has been decided upon, the contractor comes to an understanding with the parties interested as to the allegorical subjects and the various decorations that it will be necessary to represent. The pieces selected are sketched and colored upon the floor of the work room. Then large frames of light laths are constructed, and, after the design has been covered with these, flexible rattan rods are nailed thereto in following all the lines indicated upon the floor by the draughtsman.

These decorations are often of very large dimensions. Care is taken to render each frame independent, in order to facilitate carriage. Each is numbered so as to permit of its being put in the place that it is to occupy in the decorative piece as a whole, when it is mounted at the spot where it is to be set off.

Into the bamboo, which has been painted the same color as the model, are inserted, at right angles with the plane of the piece, long points upon which are impaled the port fires of the desired color. These are spaced from 12 to 20 centimeters apart, according to the distance from which the piece is to be seen. After the port fires have been put in place, all the primers with which they terminate are connected with each other by means of a quick match, made of cotton yarn, that has been impregnated with a paste of priming powder and set aside to dry. Inclosed in a paper tube, this fuse burns very rapidly, and communicates fire to all the port fires of a piece almost instantaneously. The general arrangements just mentioned are shown in the figure; at the back, the lath frame; in front, in a darker shade, the bamboo that figures the *motif* (here a D); then, at right angles with the bamboo, the port fires; and, finally, the fuse that unites them all.

The mounting of the pieces often necessitates a very large framework formed of poles planted in the earth. By means of ropes and pulleys each piece is suspended therefrom vertically in its respective position, marked in advance. It often requires several days to prepare an installation of this kind.

The part of the display that is awaited by the spectators with the most impatience is the bouquet. This consists exclusively of rockets in a greater or less number, according to the importance that it is desired to give it. Their size varies in such a way that the largest form the top of the bouquet and the smallest are found at the bottom.

They are fixed vertically by their sticks in boxes with bottoms provided with apertures. All these boxes are connected by a quick match. The bouquet set off in the display of fireworks given in honor of the Russians at Paris, on October 23, 1893, comprised 15,000 rockets that formed a mass 30 meters in length by 6 in width. It gave a gerb that rose to a height of more than 200 meters and covered the surface of a circle of nearly 300 meters in diameter.

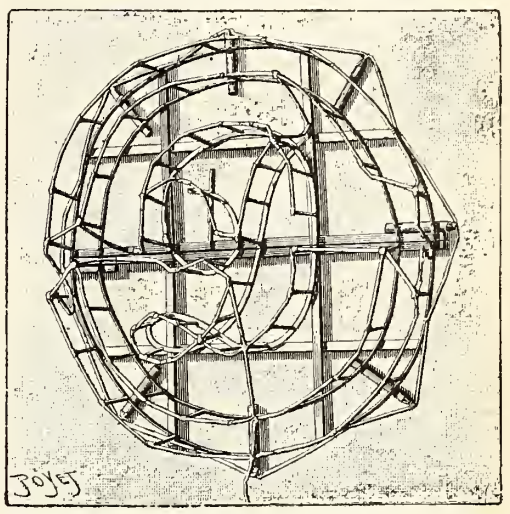
* Continued from SUPPLEMENT, No. 947, page 15128.

And now a few words as to the fire sheaves, which form the basis of all pyrotechnical pieces, such as fixed or moving cascades, mosaics, salamanders, etc. These sheaves are packed in cases like those used for rockets. The charging is likewise done mechanically, but no bore is formed as in rockets, and to the composition there are added iron or steel filings, which, in burning, give sparks of a very brilliant effect.

These sheaves serve either for revolving Catherine wheels or arms or for causing a rain of fire, mosaics, etc. Thanks to them, very varied designs are obtained.

The most remarkable pyrotechnical piece, which was created in the last century by Petronio Ruggieri, represents a salamander pursuing a butterfly, in the midst of Catherine wheels.

At the display of fireworks above mentioned, there were three large pieces: a mosaic having a frontage of 70 meters, which accompanied a large decorative piece bearing the words, "A l'Escadre Russe," in letters two meters in height; three other large pieces, called *majesteuses*, in technical language, and which consisted of wheels and palms; and, finally, two great cascades, each placed upon a parapet of the Jena bridge and falling into the Seine for a length of more than 120 meters. These were formed of 800 fire sheaves of wide caliber.




DECORATIVE PIECE FORMED OF PORT FIRES.

We shall here conclude these few notes, with the hope that they will suffice to give an idea of the genesis, so to speak, of a large display of fireworks. We trust that they will also have the practical result of making it understood how indispensable it is to take precautions at the time of installation of the pieces. At the moment that the contractor begins to erect his poles, and the pieces begin to arrive upon the grounds, the curious flock to the front in order to watch the operations of the workmen, and to examine the bombs, rockets, etc., close by. They are not satisfied to see from a distance, but wish to touch things.—*La Nature.*

## MANUFACTURE OF NITRO-GLYCERIN.*

*The General Arrangement of the Danger Area.*—A perfectly level piece of ground is unsuitable as a site for the manufacture of nitro-glycerol, as a number of buildings are required to be upon different levels, in order to allow of the flow of the liquid nitro-glycerol from one building to another through a system of conduits. The buildings inside the danger area, or that portion of the works which is devoted to the actual manufacture of explosive material, are preferably made of wood, as, in the event of an explosion, this substance offers less resistance and causes less damage than stone or brickwork. In order to confine the force of an explosion, it is also a good plan to surround all danger buildings and conduits with mounds of sand or earth, which should be covered with turf and of such a height as to be higher than the roof of the adjacent building. The conduits connecting the various buildings are generally made of wood and lined with lead, the space between the woodwork and lead lining (some four or five inches) being filled with cinders; they should also be provided with covers, which should be whitewashed in hot weather and regularly inspected. Whenever it is found that a portion of the lead lining requires repairing, before cutting away the lead it should be very carefully washed, for several feet on either side of the portion it is intended to remove, with a solution of caustic soda or potash in dilute methylated spirit; this treatment decomposes the nitro-glycerol with formation of glycerol and potassium nitrate. The mixed acids attack the lead rather quickly, forming sulphate and nitrate of lead, but chiefly the former. For this reason gutta percha pipes have been proposed, but the great drawback to their use is that in the case of anything occurring inside the pipes, such as the freezing of the nitro-glycerol in winter, it is far more difficult to find it out.

The buildings which require to be connected by conduits are, beginning with the highest, (1) the nitrating house; (2) the separating house; (3) the filter house; (4) the secondary separator; (5) the deposit of washings; and (6) the settling or precipitation house. In Great Britain these buildings require to be a specified distance apart and a license must be obtained for each. They should all be protected by a lightning conductor or covered with barbed wire, as suggested by Oliver J. Lodge. In order to keep them as cool as possible in summer, they should be made double, and the in-

* P. G. Sanford, *Jour. Anal. and Appl. Chem.*, 7, 1893, 224-229; and 7, 262-277.

tervening space filled with cinders; the roof should also be kept whitewashed and the windows thinly painted over with white paint.

A thermometer should be suspended in every house. It is essential that the floors of all the buildings should be washed every day before the workmen leave. If any nitro-glycerol is spilt on the floors, it should be sponged up and the place washed with an alcoholic solution of soda. The various houses should be connected with paths laid with cinders or boarded with planks, and any loose sand about the site of the works should be covered over with turf to prevent its blowing about and getting into the buildings. The works throughout should be heated by steam, brought in pipes covered with kieselguhr from a boiler house outside the danger area. A stove, entirely covered in with woodwork, should be placed in the corner of each building, and as small a length of steam pipes as possible should be within the building. Fire-extinguishing apparatus in proper working order should also be provided.

The work people inside the danger area should wear sewn leather shoes and different clothes, preferably without pockets, from those usually worn, which necessitates the erection of changing houses, one for the men and another for the girls. Brass nails or wooden pegs should be used in the construction of the buildings, and any necessary tools should be made of phosphor bronze or brass.

### NITRATION.

The acids used in the manufacture of nitro-glycerol should be as pure as possible. The sulphuric acid should have a specific gravity of 1·84 at 15° C. or contain 97 per cent. sulphuric acid. The nitric acid should be as strong as possible. Nothing with a specific gravity less than 1·52 should ever be used, and the oxides of nitrogen should not exceed 1 per cent. It should also be as free as possible from chlorine. An unsuccessful attempt has been made to free nitric acid from the oxides of nitrogen by blowing compressed air through it. E. Liebert claims that the addition of ammonium sulphate or nitrate to the mixed acids destroys the nitrous acid formed during the process of nitration, thus $(NH_4)_2SO_4 + 2HNO_2 = H_2SO_4 + 4H_2O + 2N_2$.

The best proportions in which to mix the acids are three parts by weight of nitric acid to five of sulphuric acid. After mixing, the acids should be forced up to the nitrating house in the danger area. They should be stored in a leaden chamber, large enough to hold sufficient acid for four or five nitrations, placed in a wooden house six or seven feet higher than the nitrating house. This house should also contain a smaller lead tank, holding, when filled up to a certain mark, just enough acid for one nitration.

The glycerol should be contained in a small cistern provided with a graduated gauge glass and fixed on the wall of the nitrating house. A good charge is 16 cwt. of the mixed acids and 247 lb. of glycerol. The nitration is usually conducted in a lead vessel, cased in woodwork, four feet wide at the bottom and rather less at the top. It is generally about four feet high, but should never be more than two-thirds full. The top of the tank is closed in with a dome of lead, in which is a small glass window through which the progress of the nitrating operation may be watched. A lead pipe is fitted to the top of the dome and carries the acid fumes up through the roof. The interior of the tank contains at least three concentric spirals of 1 inch lead pipe, through which water is made to flow during the *whole* operation. Another lead pipe is carried through the dome to the bottom of the tank, where it is bent round in the form of a circle and is pierced with small holes about one inch apart, through which air under a pressure of 60 lb. per square inch is forced in order to keep the liquids in a state of constant agitation. A 2 inch pipe brings the mixed acids and a narrow bore pipe the glycerol. Two thermometers are inserted into the tank, one near the bottom and the other near the top. A large earthenware tap (covered with lead) is fixed just above the bottom of the tank, so that the charge may be run down the conduit to the next house, or if necessary, in cases of decomposition, be discharged into a drowning tank. This is generally 16 feet long, 6 feet wide and 4 feet deep. It is placed close outside the building, is lined with cement and contains a large quantity of water. It should only be used as a last resource, as it is troublesome to recover the nitro-glycerol from the bottom.

After a charge of the mixed acids has been introduced, water is turned on through the coils and sufficient compressed air to stir up the acid. When the thermometers register 18° C. the glycerol is slowly admitted and the air turned on full. The nitration usually requires about half an hour, but a little extra time should always be allowed. The temperature should be kept as low as possible and should never exceed 25° C. The chief points to attend to during the nitration are: (1) The temperature of the two thermometers. (2) The color of the nitrous fumes given off. (3) The pressure of the compressed air. (4) The gauge showing the quantity of glycerol used. If the temperature rises too high, the glycerol should be turned off and the air pressure increased until no more red fumes are given off.

### SEPARATION.

When the nitration is over, the charge is sent down the conduit into the separator. This is a leaden tank somewhat similar to the nitrating vessel, but provided with a window of thick plate glass, which enables the workman to see when the separation is complete. The lead coils may be omitted from the separator, and one thermometer dipping into the nitro-glycerol is sufficient. The separator is connected by a conduit with the filter house and also with the secondary separator and the drowning tank, as the charge often gets very dangerous in this building. The secondary separator is used to recover a small quantity of nitro-glycerol from the spent acids. Before the nitro-glycerol is run down to the filter house it is usually washed three or four times in a smaller lead tank, with its own bulk of water, containing about three pounds of carbonate of soda to neutralize the remaining acid. It is then drawn off into India rubber buckets, and poured down the conduit to the filter house.

### FILTERING AND WASHING.

Five or six charges are usually washed at the same time. The washing tank is half filled with water, and contains a compressed air pipe for the purpose of stirring. Four or five washings are generally necessary. The nitro-glycerol is then run into the next tank, the top of which is on a level with the bottom of the first one. Across the top of the tank is stretched a piece of flannel to remove dirt and scum. It is filtered again through another piece of flannel, and is finally drawn off into rubber buckets. At this stage it is taken to the laboratory and subjected to the government heat test (see the Explosives Act, 1875, Eissler's Modern Explosives, 267). If it does not pass this test, it must be rewashed until it does. As five or six charges are often in the filter house at one time, it is necessary to have as many tanks arranged in tiers, otherwise one or two refractory charges would stop the rest of the plant.

The chief causes of the nitro-glycerol not passing the heat test are either that the acids contained some objectionable impurity or more frequently the quality of the glycerol used. The glycerol used should conform to the following tests:

1. Minimum specific gravity at 15° C., 1·261.
2. Should nitrify well.
3. Separation should be sharp within half an hour without the separation of flocculent matter (due to fatty acids), nor should any flocculent matter be formed when the nitro glycerol is thrown into water and neutralized with carbonate of soda.
4. Should be free from lime and chlorine, and contain only traces of arsenic, sulphuric acid, etc.
5. Should not leave more than 0·25 per cent. inorganic and organic residue together when evaporated in a platinum dish without ebullition (about 160° C.) or partial decomposition.
6. Silver test should not show more than slight reaction.
7. The glycerol, when diluted one-half, should give no deposit or separation of fatty acids when nitrogen peroxide gas is passed through it.

After the nitro-glycerol has passed the heat test, it is allowed to stand for a day or two in conical tanks, in order that a small quantity of water may separate. It is then of a pale yellow color, and quite clear, and should exhibit no acid reaction.

It is *impossible* to run the waste acids away or recover them as long as nitro-glycerol is contained in it. The separation is usually effected in a tank similar to the nitrating tank. The small quantity of nitro-glycerol which is obtained is taken to the filter house, and treated with another charge. The acid may then be treated by a denitration plant of some kind. The secondary separator requires more attention than any of the other houses, on account of the danger of the decomposition of the small quantities of nitro-glycerol mixed with so much acid and water formed during the process. The composition of the mixed acids after nitration is as follows: Sp. gr., 1·7075 at 15° C.; $H_2SO_4$, 67·2 per cent.; $HNO_3$, 11·05 per cent.; and water, 21·7 per cent., with as much as 2 per cent. of nitric oxide and a little nitro-glycerol. The cause of explosions in the secondary separator is either the inattention of the workmen in charge or the bursting of one of the water pipes, the water mixing with the acids causing a sudden rise of temperature. The author also describes a nitro-glycerol plant which can be used on a smaller scale.

## LARGE COTTON MILLS.

THE largest cotton mill in the country is the plant known as the Amoskeag Mills, at Manchester, N. H. The *Textile Record* says a visit to that city would be incomplete without even viewing the impressive appearance they, together with the Stark, Amory, and Langdon mills, present as they front on the upper canal. For more than a mile this frontage stretches, in well nigh uniform height of three stories, broken only by an occasional rise at intervals into a four or five storied section. Such a view would, however, convey but the faintest idea of the immensity of the great plant of the Amoskeag Manufacturing Company, to say nothing of those of its adjoining neighbors.

To get a complete idea of this vast manufacturing enterprise, however, one must have the view from one of the upper floors of the new mill, known as No. 11, which is built on an eminence far back from the front. Mill after mill lies below, with store rooms, engine rooms and other buildings so numerous that no effort would be made to count them. The mills are built in irregular order and apparently without regard to convenience, but the internal arrangements are so well perfected, and the labor-saving devices so numerous and well applied, that even the confused appearance is not so much the result of exigencies of an ever-growing demand for greater productive power as of methods carefully planned and skillfully carried out.

On the front, the water of the upper canal washes their foundations. Behind them are other buildings extending to the lower canal, further back others yet down to the Merrimack River, and still others with latest important mill additions beyond the river itself. Three watercourses are thus included in the area covered by the mills, giving a water power of unusual abundance, utilized in the Amoskeag Mills alone for driving wheels up to 12,000 horse power. Great as this is, the mills are not by any means entirely dependent upon it, for their steam resources are equal to 8,000 horse power.

The dimensions of only a few of the buildings will serve to convey an impresssion of the gigantic proportions of the whole. The largest mill of all, No. 11, already referred to, and the most recently built, is 900 ft. long by 103 wide, and 4 to 6 stories high. The Jefferson Mill, a complete factory in itself, is 512 ft. by 101 ft., 5 stories high throughout, and No. 9 is 473 ft. by 100 ft., 4 stories high. The mills in the aggregate contain a floor space of 60 acres. The cloth storehouse is 600 ft. by 72, with 3 stories, and the cotton storehouse 1,100 ft. by 68, 3 stories high, with a storage capacity for nearly 40,000 bales of cotton; while the coal shed, when full, will hold 32,000 tons of coal.

The mills contain nearly 300,000 spindles, of which over 40,000 are mules, and between 10,000 and 11,000 looms. In two mills alone, Nos. 11 and 9, are 6,000 looms, the former taking 4,000 as its share. In it one room is 533 ft. long and 103 wide, containing 1,000 looms. Every operation in cotton manufacturing is conducted within the boundaries of the mills, even to the building of looms, spinning frames, carding machines, and other mechanical and engineering work. The presiding mechanical genius of the whole is the superintendent, Captain Manning, and his inventive powers are seen in a number of time and labor saving devices in the spinning and weave rooms. The chief of these is the contrivance, by aid of an additional pulley, whereby one belt is made to drive two looms. The saving in belting and in shafting, without loss of speed or power, is said to be something remarkable. This device has not been seen in any other mill so far, but as it appears to be pretty common knowledge that such a contrivance is in operation, there is no objection to mentioning it here

The Amoskeag has the largest wood-rimmed fly wheel in the country, 30 ft. in diameter, driven by water power, while another wooden-rimmed fly wheel, 28 ft. in diameter, is said to be the largest in the country driven by steam power. It can also claim the most remarkable boiler house in the country, with its 50-odd Manning upright boilers. A boiler house ordinarily wears an uninviting appearance, but these boilers, fully exposed to view in their whole length, cased in bright sheet iron, present a really handsome appearance.

The mills employ 8,000 hands, of which about 4,500 are females, and consume 600,000 pounds of cotton per week when running full, as they are at the present time. Their productions are the well known staple fancy and fine ginghams, denims, ticks, and other coarse yarn, colored cottons and grain bags. The A.C.A. ticks were first made known to the trade in 1826, under the original Amoskeag Cotton and Wool Factory (founded 1810). The Amoskeag Manufacturing Company dates from 1831.

The Amory Mills are three in number, containing 119,152 ring spindles and 3,000 looms. They employ 1,400 hands, and consume 175,000 pounds of cotton per week.

The Stark has six mills, with 80 000 spindles and 2,500 looms, employing 1,650 hands. The former is running on sheeting, shirting, and jeans; the latter on sheeting, shirting, drills, duck, and bags, and, with the Langdon, are working on full production.

The Manchester Mills are another important concern in this city. They contain 74,000 ring spindles in the cotton mills and 18,000 worsted spindles in the dress goods mills, with 1,152 cotton and 2,075 worsted looms and 22 combs; while in the print works there are 16 printing machines. These mills are running full time in the cotton and print departments, but turning out only about 75 per cent. of normal production in the worsted dress goods division.

## POWDER FOR CANNON.

IT is rather singular that while commendable progress has been made in the manufacture of some sorts of powder for military purposes, in brown powders for heavy guns the results have been less satisfactory. The difficulty seems to be that when a good powder has been obtained it is not reproduced. Gen. Flagler noted in his annual report that when a large number of lots of powder had been manufactured for the 12 inch rifle, and the fifth lot came up to the ballistic requirements, no subsequent lot reached even a close approximation to it until the eighteenth had been delivered. It was further noteworthy that the very lot before this last gave the enormous chamber pressure of about 76,000 pounds per square inch, with a charge of only 350 pounds, although the normal charge was 450 pounds. Somewhat similar results had occurred with powder made for the 10 inch rifle.

Turning to smokeless powders for heavy guns, it is found that tests were made during the year reported upon with the French B. N., the German, the United States navy, the English cordite, the Austrian Troisdorf, and the American Leonard.

The firings of the French B. N. with the 12 inch rifle included two in 1892 and two in 1893. The weight of the projectile was 1,0.0 pounds and that of the charge 204 pounds. On July 10,1892 a firing showed 1,846 feet per second of muzzle velocity with 26,400 pounds per square inch of chamber pressure. On the following December 1 the muzzle velocity had increased to 1,957 feet per second and the chamber pressure to 28,000 pounds, the powder having been stored since August 5 in barrels. On July 25, 1893, a charge of 197 pounds thus stored, which had shrunk from 200 pounds, yielded 122 feet of muzzle velocity and 29,000 pounds of chamber pressure. But a fortnight later a 204 pound charge of powder that had been hermetically sealed since August 5,1892, yielded 1,895 feet of muzzle velocity with only 26,600 pounds of chamber pressure, thus corresponding remarkably to the original firing of the year before. So far, therefore, as these four single rounds are a guide, this French B. N. proved very satisfactory for large caliber rifles, especially when aided by hermetical sealing. It is to be observed that there is no nitro-glycerine in it.

For more than two years there have been trials of the German smokeless powder in the 8 inch rifles, with a 45 pound charge and a 300 pound projectile. The first round, July 24, 1891, gave 2,000 feet of muzzle velocity, with 30,100 pounds pressure. A year later, July 26, 1892, two more rounds were fired, one with powder ordinarily stored in barrels and the other with hermetically sealed powder, with the result that the former yielded 1,949 feet of muzzle velocity and 29,900 pounds of pressure, while the latter gave 1,968 feet and 30,400 pounds. Eight months later, March 21, 1893, another charge of the hermetically sealed powder yielded 1,973 feet and 30,100 pounds pressure, thus showing a loss of only 27 feet in muzzle velocity and not a pound of increased pressure from the original firing twenty months before. Finally, on August 28, or a little over two years after the first firing, a charge that had been stored in metallic cases, but not sealed since September 1, 1891, yielded 1,933 feet of muzzle velocity, but with a gain to 32,400 feet of chamber pressure. On the whole, this German smokeless powder also shows up to good advantage, especially as hermetical sealing is perfectly practicable in forts, and will be made the rule in our service. And yet this powder contains nitro-glycerine. Our ordnance department hesitates to affirm or deny that this substance injures keeping qualities, and had found nothing against it up to a recent date. One marked ad-

vantage of the German powder is that the cubical form of its grain facilitates making up cartridges.

Cordite is the regular service smokeless powder in England for rapid fire guns, and it has been used experimentally for heavy ordnance. It contains nitro-glycerine, but the English government seems to have satisfactory evidence of its stability. A couple of rounds of it in a 4·7 inch quick-firing Armstrong, tried by our ordnance authorities, with a charge of 5½ pounds and a 45 pound projectile, yielded the good muzzle velocity of 2,229 feet, with a powder pressure of 31,500 pounds.

The Troisdorf powder, which has no nitro-glycerine and is but slightly affected by heat, was tried in the 5-inch siege rifle. A round with 6 pounds 10 ounces yielded 2,049 feet of muzzle velocity and 33,200 pounds of chamber pressure; but another round with 6 pounds 12 ounces and the same 45 pound projectile, with an increase only to 2,071 feet of muzzle velocity, is said, unless there is an error in the printing, to have yielded 37,500 pounds of chamber pressure.

But the most remarkable results are those obtained with the American Leonard powder in the 5-inch Brown segmental wire gun with a 63 pound projectile. A 15 pound charge yielded 2,397 feet of muzzle velocity and 32,800 pounds of chamber pressure. A charge of 17 pounds yielded 2,521 feet, with 35,100 pounds; a charge of 21 pounds yielded 2,874 feet and 46,600 pounds. The Leonard has also made a great record for itself as a powder for military small arms. It is believed to contain nitro-glycerine, but it provides good keeping qualities, and these latter are to be tested thoroughly. Tried in 3·2 inch field guns, it showed a superiority over the French B. N., the United States navy, and the Troisdorf. It may be remarked that the sample of navy powder used did not appear well adapted to a gun of such small caliber as the 3·2 inch, since much of it was thrown out unconsumed. While experimenting with the Troisdorf powders it was found that a short cartridge of large diameter gave a much higher pressure than if made up into a cartridge of smaller diameter extending the whole length of the chamber.

One further point in this matter may be noted. While smokeless powders yield a much higher velocity, it is said that the high heat they evolve, especially those that are chemically combined, fuses and corrodes the metal at the surface of the bore, and perhaps alters the molecular condition of the steel. This would shorten the life of the gun. Still, since the advantages given by a smokeless powder are great, the remedy suggested is that of relining the gun when necessary with a thin tube. This in its turn would be a troublesome and costly operation, so that possibly a compromise may be made in demanding less remarkable ballistic results for the sake of producing less wear on the cannon.—*N. Y. Sun.*

## H. M. S. HAVOCK—TORPEDO BOAT DESTROYER.

ON Saturday, December 2, we were favored with an opportunity of enjoying a prolonged trip from Gravesend upon the above vessel, which has just been completed for her Majesty's navy by Messrs. Yarrow & Co., of Poplar. The party on board consisted of some 120 interested persons, and, as the day was remarkably fine, though frosty, a very enjoyable trip of about 100 miles was experienced. The Havock forms the first of a fleet of thirteen vessels ordered by the Admiralty from different builders, and intended for overhauling and destroying hostile torpedo boats, and to accomplish this must necessarily have a speed of from 26 to 27 knots.

The honor of having turned out the first vessel of this new type has fallen upon Messrs. Yarrow & Co. The Havock passed through all her official trials with perfect success and without the slightest hitch; the mean speed tested under the stringent conditions enforced, carrying a load of 35 tons, was rather more than 26 knots an hour during a continuous full speed run of three hours' duration. The speed stipulated for in the contract was 26 knots an hour, and all who were present at the trials were thoroughly convinced that the principal difficulty those in charge had to contend with was rather to prevent the boat running away altogether than to attain the speed stipulated. During the three hours' run there were periods when she exceeded 27 knots an hour, the engines exerting about 3,500 horse power, and this was obtained a few weeks ago out in the German Ocean in bad weather.

The Havock is 180 ft. long by 18 ft. 6 in. beam; is a single deck vessel, in form greatly resembling the first-class sea-going torpedo boats built by this firm. Forward there is a long turtle deck, well elevated above the water line, which covers in a lofty forecastle, in which the larger number of the crew are berthed. At the after end of this turtle deck is the usual conning tower with steering wheel. The next compartment is filled up with berths, and abaft a separate compartment is devoted to the cook, and contains also fresh water tanks and two more berths. From the galley to the engine room are the two boiler compartments containing each a powerful locomotive boiler with copper fire box, each boiler being capable of working up to 180 lb. per square inch, and of generating steam sufficient for the development of 1,800 horse power, to produce which requires no less than 30 cwt. of coal per hour. The engine room contains two sets of inverted triple-expansion engines capable of developing collectively without undue forcing 3,500 horse power, each set of engines driving a screw. In the same compartment are two surface condensers, two centrifugal pumps and engines for driving them, fan engines, steam bilge pump, evaporator and distiller, air-compressing engines, and engine dynamo for the search light; and, lastly, the engine for actuating the rudder, which can be controlled from either the forward or after steering station. Abaft the engine room are two cabins for the engine room artificers, then comes the officers' mess room with its pantry, and last of all, quite at the stern, a large store space.

The armament consists of an 18 in. bow torpedo tube for firing direct ahead; also, two 18 in. swivel torpedo tubes for side firing, which are placed on a turntable well aft of the center of the hull. On the forward conning tower, well elevated above the water line, is a 12 pounder quick-firing gun, which practically has an all-round range. There are also two 6 pounder quick-firing guns, one at each side, and finally, a 6 pounder placed on a high stand near the stern, which, owing to its position, has a very extensive range of fire. The depth of the boat being so much greater than is necessary for head room, admits of a water-tight flat or lower deck: this has been built in the boat just above the water line, extending from the stem to the forward stoke hold, which adds greatly to the safety of the craft in case of collision, and below under the floors of the cabins are spaces for magazines and stores. The coal carrying capacity of the Havock is 60 tons, and the supply is placed in bunkers along each side of the boiler compartments, and is estimated to be sufficient for a run of 3,500 miles at a 10 knot speed. The complement of officers and men to man this vessel is 42, for whom there is sufficient accommodation, but they must expect to be rather closely packed.

The propellers are three bladed, and the engines have cylinders 18 in., 26 in., and 39½ in. diameter, by 18 in. stroke. A piston valve is provided to each cylinder, and vertical vibrations are prevented by "bob weights," as described by Mr. Yarrow in his paper before the Institution of Naval Architects. The steering capabilities of the Havock are good, her minimum turning circle being, it is stated, 200 ft.—*Industries.*

## WILLIAM SHOTTON.

YET another addition to the list of heroic Englishmen, though this time it is a lad of only eighteen years of age, William Shotton, of Sunderland. The ship Trafalgar, a big, four masted bark, of which Shotton was an apprentice, put off from Batavia for Melbourne. Fever broke out among the crew, and one after another the captain and all the mates died or were too ill to move. The command fell on the young shoulders of Shotton. With the captain dead, the chief mate a raving lunatic, and half the crew sick, this youth, at the age when many English boys are thinking of nothing but football and cricket, took command of the fever-stricken vessel, and with no officer to help him, navigated her through a stormy voyage of several weeks, till at last Melbourne was safely made. A splendid piece of work, and while we have such youngsters as Mr. Shotton in our merchant service we need have no fear of our losing command of the seas.—*St. James's Budget.*

WILLIAM SHOTTON, THE BOY CAPTAIN.

## JOSEPH WILSON SWAN.

To Joseph Wilson Swan belongs the honor of having invented the carbon incandescent lamp, as well as of having perfected the process of its manufacture, although he unfortunately delayed in applying for a patent, and was thus, for legal purposes, forestalled by Mr. Edison.

Pirating a phrase of Wendell Holmes, Mr. Swan says he is sixty-five years young! To be exact, Joseph Wilson Swan's birthday was October 31, 1828. He is a native of Sunderland, was educated there, and lived there until his eighteenth year, when he removed to Newcastle-upon-Tyne. At Newcastle Mr. Swan spent the next thirty-five years of his life—chiefly in commercial pursuits. These were, for the most part, connected with chemistry, and did not prevent, but rather helped, Mr. Swan to keep in touch with progress in scientific discovery. It was during this time that he carried out the experimental work which culminated in the invention of his electric lamp. For the last twelve years he has resided at Bromley, Kent, where he has devoted himself entirely to research—chiefly in relation to electro-chemistry. Some of the results of this work were brought out at the lecture delivered by Mr. Swan at the Royal Institution last year.

Mr. Swan is what is popularly known as a self-made man, that is to say, he does not owe a very large debt of obligation to educational training. The days of his youth were not the days of physical science colleges. What scientific knowledge Mr. Swan acquired in early life, he acquired in spite of great difficulties and discouragements. Mr. Swan is a born inventor. The bias of his mind is essentially scientific and artistic, and his inventions, which are many, lie in these domains.

His name is known most widely in connection with the incandescent electric lamp. The first lamp ever publicly exhibited, having the typical features of the lamp which has done more than anything else to popularize electric lighting, was exhibited by Mr. Swan in 1879. Another of Mr. Swan's inventions (the carbon process) has made his name a household word among photographers all over the world, but the public do not so generally know that it is to Mr. Swan we owe this most excellent of all the permanent photographic processes for the facsimile reproduction of works of art. This was the outcome of the work and ideas of thirty years ago, when Mr. Swan was greatly interested in the manufacture of collodion, a manufacture which he brought to a high state of perfection by means of an original method of making pyroxyline, which has never been published.

The world of art also owes to Mr. Swan, conjointly with Mr. Woodbury, the discovery of a new principle in mechanical printing, on which is based the process known as Woodburytype. In applying photography to ordinary mechanical modes of printing, Mr. Swan was one of the first, if not *the* first, to recognize the necessity for changing the uniform character of the gradation of light and shade in a photograph to gradation of a different character adapted to the usual methods of mechanical printing. In a more or less modified and improved form, Mr. Swan's devices to this end—patented many years ago—are still employed, and their results are seen in the wonderful photogravure reproductions of pictures, which have done so much to familiarize the public with good works of art, and in the photographic block illustrations which are so frequently seen in periodical literature. The great revolution in the art of photography, which has made every other man, woman, and child a photographer, originated in the discovery by Mr. Swan of the now universally known means of so greatly accelerating, by the action of heat, the sensitiveness of bromide of silver diffused through gelatine. Mr. Swan may justly be said to have created the modern "dry plate," though he did not publish his discovery except through the medium of a new manufacture, the secret of which very quickly spread in every direction.

Among the multitude of inventors associated with the improvement of the Plante-Faure secondary battery, it is apt to be forgotten that Mr. Swan was the originator of the cellular form of accumulator plate, and that it was he who first produced a miners' electric safety lamp, by a combination of his two inventions of the incandescent lamp and an improved secondary cell. We have not space to enter fully into descriptions of all Mr. Swan's inventions, but we cannot omit to mention his motor electric meter, which was one of the earliest of this type, nor his electric fire-damp detector.

Mr. Swan's latest achievement is the production of gold leaf by electro-deposition, and *apropos* of this, he has been heard to remark, with a twinkle in his eye, that it was the only form of gold that had ever stuck to his fingers. The late President of the French Republic and the University of Durham were among the foremost to publicly recognize the merits of Mr. Swan's invention of the incandescent lamp, the former creating him chevalier of the Legion of Honor and the latter conferring on him the degree of M.A. *honoris causa.*

A man of varied tastes and accomplishments, in literary matters Mr. Swan is critical and fastidious, and is a passionate lover of poetry. He has Tennyson by heart in every sense; nearly all the master wrote is as much in his mind as in his library. The anniversary of Mr. Swan's birthday has just passed, and we heartily wish him many happy returns.—*The Electrician, London.*

## ELECTRIC HAULING AT THE MINES OF THE BROCK COAL COMPANY, PENN.

THE mines of the Brock Coal Company consist of five drift openings in a hillside about half a mile southeast of the town of Brockwayville, Jefferson County, Pa. But four of these drifts are in operation, viz., Nos. 1, 3, 4 and 5. The seam of coal worked averages 31 in. thick. In some places it is as much as 42 in. thick, and at others it is pinched out entirely. The present production of the four drifts ranges from 300 to 400 tons per day. The inclination of the seam is very slight, being merely enough to insure natural drainage for about 5 in. in 100 ft. This dip is very regular. The seam has a hard sandstone top and a soft fireclay bottom. The coal produced is delivered at two different points. That for shipment is delivered to chutes on the Brock Coal Company's branch railroad, and from them loaded into railroad cars. The balance goes to chutes on the Ridgway & Clearfield branch of the Philadelphia & Erie Railroad, and is taken from them by the railroad company for locomotive use.

The outside tramway connecting the four drifts with the two sets of chutes is about one mile in length. It runs along the hillside and is constructed of 25 lb. T-rail. The gauge of the track is 30 in. There are grades on this line of 4·67 per cent. for 250 ft.; 3·63 per cent. for 672 ft.; 2·37 per cent. for 758 ft.; and 1·61 per cent. for 715 ft., all of these being in favor of the load. The inside grades are very regular and are about 5 in. in 100 ft. in favor of the load. There are no very sharp curves. The feeder is insulated copper wire of No. 00 B. & S. gauge, and the trolley wire is a bare copper wire of No. 0 B. & S. gauge. The feeder wire runs from the power house across the tracks to a point on the hillside above the tracks, and thence to No. 5 drift. The trolley wire runs along the upper side and close to the track. It was desirable to have a substantial, economical and convenient system of haulage suitable for a track laid with light rails running in headings or gangways where mule haulage was impossible unless excessively large quantities of the fireclay bottom were taken up. Electric haulage was deemed the best for the existing conditions, and the contract for the two locomotives and the entire plant was given the General Electric Company. The plant is such as will commend it to any practical visitor.

Two locomotives are used, each of the same type and capacity. These locomotives, designed and built by the General Electric Company, are known as T. M. M., with a capacity of 1,500 lb. drawbar pull each. They are each 32 in. high, 48 in. wide and 9 ft. 6 in. long. The wheels are 30 in., and the axles 3¾ in. in diameter. The wheel base, which is rigid, is 42 in. Each locomotive weighs about 9,500 lb., and has two motors of the new ironclad street railway type, equipped with four-pole Gramme toothed-ring armatures. The armatures are series connected so as to use only two brushes each, and these are on the upper side of the commutator, and in an easily accessible position. The armatures are connected with the axles by machine-cut single reduction gears running in gear cases filled with oil. The

frames are of cast steel and of such shape as to thoroughly protect the spools and armatures, which are thoroughly waterproofed. The trolley arms are supplied with universal joints, so that they accommodate themselves to any position required by the location of the trolley wire. Power is furnished the locomotives from a Thomson Houston D 40-220 volt generator run by an old style McEwen engine of about 80 horse power.

The rails used inside are 20 lb. T-rails, and the trolley wire is suspended from the roof, though in most instances it is over the ditch instead of being on the high side, as it is at the point where the section was taken. The "ear" or insulated hanger is used for suspending the trolley wire in position. It differs from the hanger used in earlier plants constructed by the General Electric Company, in that the wire is fastened to it by screws instead of by soldering, thus making changes and repairs easier and less expensive. These hangers are fastened to the roof by first drilling two holes into the top. Ordinary bolts with hexagonal heads are placed in the holes with the screw end down. They are wedged tightly in place by two semicircular wedges, one of which is inserted with the thick end up. The other is then driven up on the opposite side, point up. This fastens the bolts securely in place with the screw ends projecting. Then a piece of $4 \times 3$ in. timber, with holes bored through it just large enough to accommodate the bolts, is placed against the top. Nuts are then screwed tightly on the ends of the bolts that extend through the block, and the hanger is screwed into the wood.

In practice the locomotives have entirely replaced the mules. Each locomotive leaves the chutes with its train of 26 empty cars and when the live workings are reached drops them at the various working places. It then returns, picking up loaded cars one by one, and at some points two at a time, and returns with them to the chutes every 40 minutes. The 26 loaded cars will average 20 tons of coal. Dynamometer tests made on one of the locomotives showed a steady drawbar pull of 2,700 lb., or nearly 100 per cent. overload. The locomotive is very compact, and it is low enough to run in much smaller headings than those at the Brock mine. It is conveniently arranged, so that the motorman can control it perfectly without leaving his seat. On the surface the trolley wire is suspended at a uniform height and distance from the rail. This is also the case in the mine, as far as possible, but it is not always practicable, and the special trolley arm is therefore required. The crew employed with each locomotive consists of a motorman at $2 per day and a boy spragger at $1.25 per day.

A statement from the company gives the average cost of producing coal for eight months before the introduction of the electric plant at 83 678 cents per ton on an output of 43,454 tons. In March and April, 1893, with the electric plant the cost was 74 576 cents per ton on an output of 15,415 tons. The cost of hauling is not given separately.—*Eng. and Min. Jour.*

## THE RUSTING OF IRON AND STEEL.

"The phenomena of chemical combination," says *Engineering*, "appear to be exceedingly complex. Not so very many years ago we were taught that a mixture of oxygen and hydrogen would combine to form water when an electric spark was passed through them. The matter appeared simple, was easily expressed in chemical formulæ and illustrated by experiment. Now we have learned that it is impossible to make such a mixture explode when it consists of perfectly pure and dry gases. When, however, the slightest trace of moisture is present, the combination takes place at once, thus illustrating the importance of those 'next-to-nothings' which were so ably and so pleasantly discussed by Sir Frederick Bramwell in his address to the British Association.

"The oxidation of iron, though a more familiar phenomenon, is at least as complex as that of hydrogen. In spite of the proverb, this familiarity has been very far from breeding contempt, as its commercial importance has attracted very considerable attention to the subject, and though there is still much to be learned, some few facts appear to be now established. In the first place, neither bright iron nor steel will rust in pure water or in pure air. The presence of carbonic acid, or some similar agent, seems necessary, although the final product may be destitute of carbon. Even when oxygen, moisture and carbonic acid are all present, rusting will not, it appears, take place unless the moisture condenses on the surface of the metal. When rusting does take place under ordinary circumstances, the first stage appears to be the formation of ferrous carbonate. This carbonate is then dissolved in carbonic acid water to form ferrous bicarbonate, which latter is then decomposed in presence of air and moisture to form hydrated ferric oxide, magnetic oxide being formed as an intermediate product. This fact as to the formation of the magnetic oxide is curious, as the Bower-Barff process of protecting iron and steel consists in coating the metal with a firmly adherent layer of this very oxide.

"Every one knows that when a bar of iron has commenced to rust the corrosion proceeds apace. A polished bar will resist oxidation for a comparatively long time, even under somewhat unfavorable conditions, but once the rust has commenced to form, it does not take long for it to cover the whole of the bar. One reason for this may be the fact that the rust is electro-positive to the iron, but it is also partly attributable to the final product, the hydrated ferric oxide, being only formed at the end of several intermediate stages of the oxidation and to its hygroscopic properties, which favor the absorption of moisture from the air. In certain situations, other acids besides carbonic may take part in the corrosion of iron. The metal work in bridges over railways is particularly exposed to fumes, and some engineers consider that in such cases no plates less than ⅜ in. thick should be made use of, even in the case of the flooring.

"The whole question of the rusting of iron and steel work has been discussed in considerable detail by Mr. Thomas Turner, Assoc. R.S.M., F.I.C., in a paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers. It is now pretty generally acknowledged that, so far as ordinary exposure to the weather is concerned, iron is less liable to rust than steel. Unfortunately, however, this capacity for resisting rust seems to be greater in the common irons than in the best qualities, and has been attributed to the phosphorus contained in the former, which seems to have a protective action.

"When iron and steel are used in conjunction, there is no certainty which will be the more liable to rust. The potential difference of contact between the two is very small, and though in general wrought iron is found to be electro-positive to steel, there seem reasons for believing that this may not be so in all conditions.

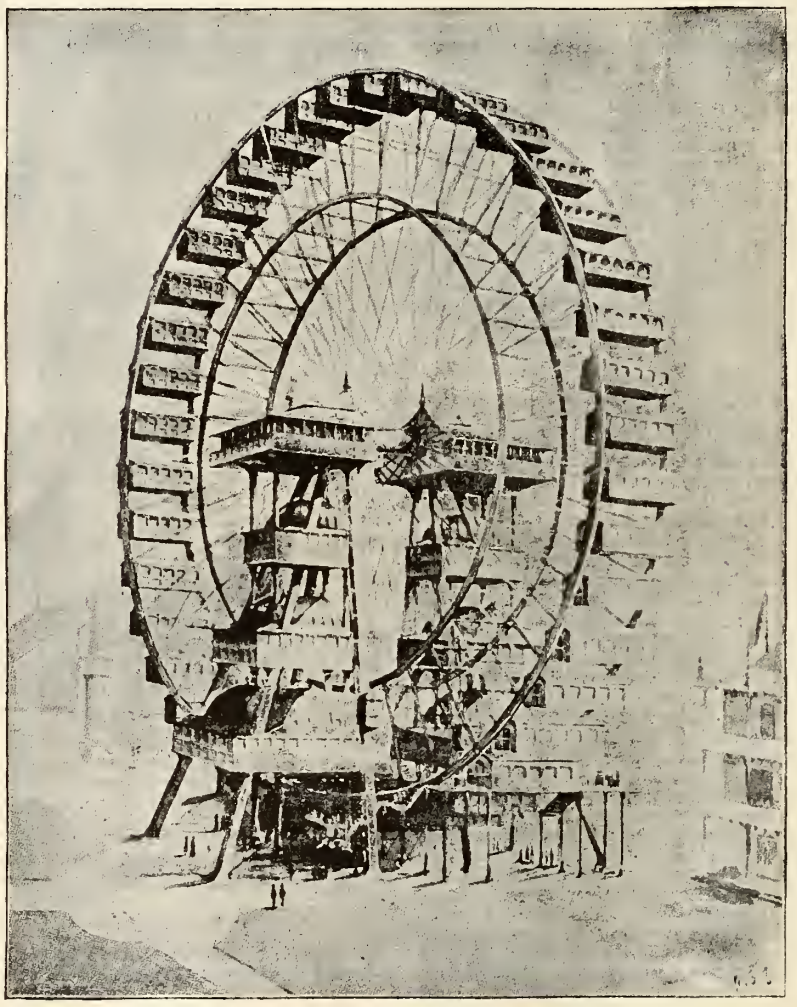
"Mr. W. Denny has instanced a case in which the steel shell plates of a vessel remained clean, while the iron stem plate and rudder forgings were much corroded. The ballast tanks of ships are particularly exposed to rust. Bilge water is an exceptionally powerful corroding agent, and several engineers have suggested the use of iron plating in ships in those parts exposed to bilge water, even when the body of the ship is of steel. In steam boilers it is claimed that there is little difference in the behavior of the two metals, and certainly steel boilers, when properly looked after, have been proved to have a long life. Plates thoroughly cleaned from scale are less liable to corrosion than when used just as they come from the rolls; and the Admiralty have accordingly adopted the practice of pickling the plates before being used. In a case of pitting, Mr. John found a particle of black oxide at the bottom of each pit. Experiment shows that this black oxide is strongly electro-positive to the plates.

"Cast iron seems in general to last better in sea water than either wrought iron or steel. Trautwine, however, relates that the cast iron cannons of the Royal George and the Royal Edgar, after an immersion of 62 and 133 years respectively, had become quite soft and were in some cases like plumbago. A very similar experience was noted with the cast iron sluice gates of the Caledonian Canal. Much apparently depends on the quality of the iron. Trautwine recommends white close-grained cast iron, while Mr. Turner quotes from a British Association report recommending gray iron.

"The alloys of iron with nickel, cobalt and chromium appear less liable to rust than ordinary iron, while the presence of manganese appears to render the iron more sensitive to attack by corrosion."

## AN ENGLISH FERRIS WHEEL.

Visitors to the next exhibition at Earl's Court, London, will, in all probability, says the *St. James's Budget*, see what will prove to be a rival to the Watkin tower—namely, an enormous wheel and recreation towers, something after the style of the Ferris Wheel, at Chicago. The wheel, which has been designed and is being constructed by Mr. Walter Basset, of Messrs. Maudslay, Sons & Field, Limited, is to be 300 feet high, and will have suspended on its periphery 40 carriages, so hung on steel spindles that the floors will always be level. Each carriage will have glass sashes all round, with railings outside to prevent its occupants falling out. It is to be constructed entirely of steel and will be on the tension principle—*i. e.*, the weight of the periphery will always be carried by the lower half of the spokes, which will be in tension. The axle of the wheel will be formed of a tube 7 feet in diameter and 50 feet long and will be supported on 8 steel columns about 160 feet high, which will be firmly fixed on large blocks of concrete embedded in the ground, each block being 15 cubic feet. Four columns will be placed on each side of the wheel, supporting four stories, intended for refreshment rooms, the two top floors being connected by means of the tubular axle. Each of these towers will contain a searchlight, and the whole of the wheel and the towers will be illuminated with incandescent lamps. Four hydraulic lifts will give access to the various floors of the towers, in addition to two staircases. The wheel, when stopped in its proper position, will have 8 of the carriages opposite their landing stages, and thus the wheel will stop 5 times during one revolution, and during these 5 stops can fill its carriages with passengers and raise them to the height of its upper rim. The motive power will be two 50 horse power electric motors, geared by means of a worm wheel to a large drum, round which will travel two 6 inch wire hawsers, which will pass over grooves on the edge of the wheel. When filled the wheel will accommodate 1,600 persons, while the towers will hold as many more. The offices of the company are at 9 Bridge Street, Westminster.



THE NEW "FERRIS WHEEL" FOR EARL'S COURT.

## WIND PRESSURE.

Prof. Kernot, at a meeting of the Australian Association for the Advancement of Science, submitted a paper on "Wind Pressure," which has attracted considerable attention in the engineering world. The professor, who occupies the chair of engineering in the Melbourne University, noted the inconsistencies appearing in engineering and architectural practice, with regard to wind bracing of chimneys, roofs, bridges, etc., and to the great variation in the anemometric results given by the meteorological observatories; some observatories, such as Bidstone, near Liverpool, England, and Sydney, recording pressures, or velocities corresponding to pressures, of 90 pounds or 100 pounds per square foot, while others, such as Greenwich and Edinburgh, Melbourne and Adelaide, give results only one third as great; and it was pointed out that these latter results correspond fairly well with the usual experience with railway carriages and chimneys, great numbers of which would overturn with pressures of not more than 30 pounds per square foot, and yet as a matter of fact do not overturn, and are regarded by the public as perfectly safe. Reference was next made to the experiments tried by Sir B. Baker at the Forth bridge, which showed that the average pressure on surfaces as large as railway carriages, houses, or bridges never exceeded two thirds of that upon small surfaces of 1 or 2 square feet, such as have been used at observatories, and also that an inertia effect which is frequently overlooked may cause some forms of anemometer to give false results enormously exceeding the correct indication.

The very elaborate experiments of Mr. O. T. Crosby, detailed in *Engineering* of June 13, 1890, were next dealt with. These experiments showed that the pressure varied directly as the velocity, whereas all the early investigators, from the time of Smeaton onward, made it vary as the square of the velocity. Experiments made by the author of the paper, at speeds varying from 2 to 15 miles per hour, were described, which agreed with the earlier authorities, and tended to negative Crosby's results. It was pointed out, however, that tests on a greatly extended range of velocities were needed.

The paper next described an apparatus devised by the author for determining the relative pressure of the wind on flat plates, cubes, cylinders, spheres, and other geometrical forms. This apparatus consists of a screw propeller similar to that used on steamers, 28 inches diameter and 48 inches pitch, on a 30 inch tube. This propeller is caused to revolve at speeds varying from 400 to 800 revolutions per minute by means of a gas engine. The helical currents of air proceeding from the propeller are gathered up and discharged in one approximately steady jet of $12 \times 10$ inch section, by

means of a radial diaphragm and a conical mouthpiece, having its axis tangential to the helical direction of the air. In front of this jet was placed the object to be tested, supported upon a very delicately made carriage, running on an accurately leveled surface plate, the force exerted being measured by a delicate spring balance, the accuracy of w. ich has been verified by means of standard weights. A large number of experiments were made with this apparatus, and many interesting and valuable facts elucidated. The ratio existing between the normal pressure on a sloping surface, such as a roof, and that upon a vertical plane was found to agree with the table given in Stoney on "Stresses," p. 524; but it was found that this result applied only to roofs supported on thin columns, under which the wind could blow freely. When the roof was placed upon a wall, as in an ordinary building, the wall deflected the current of air upward, and greatly reduced the pressure on the roof. If the wall was provided with a parapet of ordinary proportions, this effect was still more marked, the pressure being reduced to one third of what it would otherwise have been. In the case of a roof of 30 degrees pitch the pressure was actually reversed, the roof having a slight tendency to lift. In these experiments the parapet was made only one sixth the height of the roof, measured from the level of the eaves to the ridge.

Experiments were also made as to the effect of a wind blowing in at the open end of a building having the sides and other end completely closed, and it was found that the internal pressure tending to lift the roof was equal to the pressure of the wind on a flat vertical surface. The pressure upon one side of a cube, or of a block proportioned like an ordinary carriage, was found to be 0·9 of that upon a thin plate of the same area. The same result was obtained for a square tower. If the cube or tower were placed so that the wind blew in the direction of a diagonal, the total pressure was just the same as when one side was presented.

A square pyramid whose height was three times its base, and which represented a common form of church spire, experienced 0·8 of the pressure upon a thin plate equal to one of its sides, but if an angle was turned to the wind, the pressure was increased by fully 20 per cent., a curious contrast to the action on a cube or square tower.

A bridge consisting of two plate girders connected by a deck at the top was found to experience 0·9 of the pressure on a thin plate equal in size to one girder, when the distance between the girders was equal to their depth, and this was increased by one-fifth when the distance between the girders was double the depth.

A lattice work in which the area of the openings was 55 per cent. of the whole area experienced a pressure of 80 per cent. of that upon a plate of the same area. The pressure upon cylinders and cones was proved to be equal to half that upon the diametral planes, and that upon an octagonal prism to be 20 per cent. greater than upon the circumscribing cylinder. A sphere was subject to a pressure of 0·36 of that upon a thin circular plate of equal diameter. A hemispherical cup gave the same result as the sphere; when its convexity was turned to the wind, the pressure was 1·15 of that on a flat plate of equal diameter.

When a plane surface parallel to the direction of the wind was brought nearly into contact with a cylinder or sphere, the pressure on the latter bodies was augmented by about 20 per cent., owing to the lateral escape of the air being checked. Thus it is possible for the security of a tower or chimney to be impaired by the erection of a building nearly touching it on one side.

A number of interesting experiments were made upon the shelter which one surface affords to another. This shelter was found to extend in front to a distance about equal to the breadth of the sheltering surface, and behind to several times that distance. For example, a 9-inch disk being used as the sheltering surface, and a 6-inch disk being placed 2 inches in front of it, the latter received only two-thirds of the pressure it endured if the larger disk were removed, and this reduction in pressure was perceptible, though to a less extent, at all distances up to 9 inches. Behind flat surfaces eddies were found to exist, which caused other surfaces placed behind to be urged forward with considerable force. For example, a 7-inch disk placed behind a 6-inch disk, and 4 inches from it, was urged forward with one-fifth of the pressure with which it was urged backward when the 9-inch disk was removed.

In conclusion, it was recommended that 20 pounds per square foot be taken as the maximum wind pressure upon areas of not less than 300 square feet, and 30 pounds for smaller areas in positions of full exposure in the southern and southeastern parts of Australia; that in more or less sheltered positions these values might be reduced according to judgment, the minimum for extremely sheltered positions being taken as one-half the above figures; that the pressure on chimneys, towers, spires, roofs and other objects be deduced from those on thin plates of equal area by means of the results previously given; and that a factor of safety of 2 for cases of simple stability and 3 where the question is one of strength should be employed.

## VISCOSIMETRY.

PROF. PERRY has recently made some experiments on liquid friction with the apparatus shown in Figs. 1 and 2. A piece of apparatus of this nature was designed and partly constructed in Japan in 1876; that actually used was constructed at the Finsbury Technical College in 1882, but the observations only date from 1891. The simplest hydrodynamical condition of a viscous fluid is that of a fluid bounded by two infinite parallel planes, the fluid at one boundary being at rest, the velocity at the other boundary being constant and in the plane. Motions in a pipe and near a vibrating disk, or even near a steadily rotating disk, are rather complicated. The apparatus used by Prof. Perry was designed to approach as nearly as possible to the conditions subsisting between two infinite planes. Instead of planes, concentric cylindric surfaces of as large radii and as small difference in radii as could be conveniently constructed were used. E E (Figs. 1 and 2) is a cylindric trough, of which the curved parts, E, are brass.

The inner and outer radii of this trough were 10·39 and 12·65 cm.; C, which formed the bottom, was of iron, and the whole trough could be rotated about its vertical axis at any desired speed by driving the pulley, P, from a coned pulley, D, with numerous steps. G is a hollow brass cylinder supported by a steel wire, L, of 0·037 cm. diameter, 67·78 cm. long, whose axis coincides with the axis of the trough and the axis of rotation. G may be raised or lowered relatively to the trough. The outer radius of G is 11·63 cm., the inner being 11·41 cm. The whole apparatus was supported on a stand with three adjustable feet. The trough contained the liquid whose viscosity was to be determined when it rotates; G tends to rotate, and when for any constant speed G is in equilibrium, the twist in the steel wire measures the torque due to the tractive forces with which the liquid acts upon G at its inner and outer surfaces. The twist was measured by the angular motion of a pointer clamped on the wire at a distance of 59 cm. from the fixed end.

Two methods of determining the torsional constant of the wire were employed. In the first method a fine cotton thread was wound round the outside of the suspended cylinder and passed over a nearly frictionless pulley to a scale pan. The thread was nearly horizontal as it left the cylinder. In this way it was found that the twisting moment required to produce a point rotation of one degree was 1,531 dyne-centimeters. The effects due to solid friction were eliminated by taking the mean of the limiting weights for equilibrium. When the weight was 30 grammes, one-tenth of a gramme either added to or taken from the scale pan produced a perceptible change in the position of the pointer; so that the solid friction was small. In the second method the suspended cylinder was allowed to vibrate, twisting and untwisting the wire; and its times of oscillation were noted. The observations were repeated when a known moment of inertia had been added. Unloaded, it made forty complete oscillations in 583 seconds, or one oscillation in 14·575 seconds. An iron bar of rectangular section, whose own moment of inertia had been determined accurately by previous experiments, was then attached to the cylinder, this moment of inertia being 566·2, in gramme-centimeter units.

The time of a complete oscillation was found to be 21·425 seconds. From this the moment of inertia of the suspended cylinder was found to be 487·72, and the torsional constant of the wire could be obtained. From this followed that to produce a rotation of the pointer of one degree requires a torque of 1,552 dyne-centimeters. The mean value of the diameter of the wire was 0·0371 in.

Many observations have been made with this apparatus during the last year on various liquids, under very different conditions of temperature and speed and depth. In all cases the bottom of the trough was 0·5 cm. below the edge of the suspended cylinder. Keeping the oil to be tested at a constant temperature, the trough was run at a number of speeds. When a temperature had to be taken the rotation was stopped and a thermometer dipped about half way down in the oil, the reading being taken at the end of about half a minute. A small Bunsen flame was applied underneath the trough when a temperature higher than that of the room had to be maintained for a considerable time.

Sperm oil was the liquid upon which the majority of the experiments were made. The curves for this material have not been published, nor has Prof. Perry thought it worth while to make public the observations which were made upon other liquids, as errors of one degree in observing temperature were quite possible, as were also errors of half a degree in taking the deflection of the pointer. Small fluctuations in speed were continually taking place, so that the pointer was never quite still, and the motion of the fluid was therefore not truly steady.

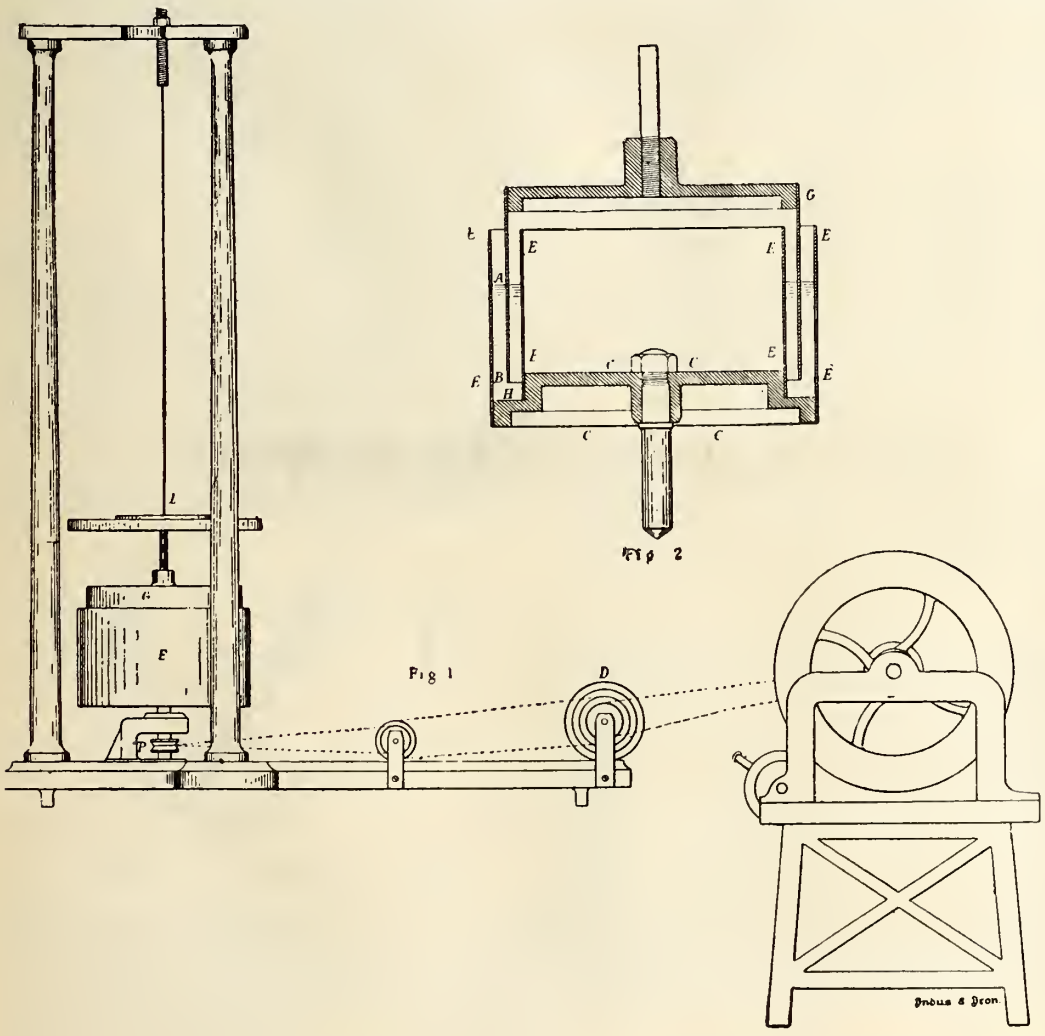



FIG. 1.—VIEW OF APPARATUS MOUNTED FOR USE.

FIG. 2.—SECTION OF CONCENTRIC CHAMBERS.

FIG. 3

FIG 4

FIG. 5.

## EXPERIMENTS ON VISCOSIMETRY.

The results obtained with sperm oil have been presented in a memoir laid before the Physical Society, but they have not yet been put into a form which would be of service to engineers. Such trials will be repeated with improved apparatus much more carefully constructed, and a series of liquids will be tested, when we may expect the results to be of some practical importance. In testing sperm oil a discontinuity of some kind due to rise of temperature was found in the value of the viscosity adduced from the experiments. This has been confirmed by measurements of the specific gravity of that oil at different temperatures. The following table gives the results obtained:

| Temperature Cent. | Specific gravity. |
|---|---|
| 25° | 0·831 |
| 30° | 0·8306 |
| 35° | 0·828 |
| 40° | 0·826 |
| 45° | 0·8758 |
| 50° | 0·8753 |
| 55° | 0·8717 |

Tests of sperm oil with an apparatus which gave, not the absolute value of the specific gravity, but the relative rate of change of specific gravity with change of temperature, exhibited no sign of discontinuity, but this is not sufficient reason to doubt the accuracy of the values given in the above table.

*A New Torsion Viscosimeter.*—The viscosity of oils is usually determined by viscosimeters, which are based on the principle of allowing the oil to flow through an orifice and counting the number of seconds required for a certain quantity to flow out. They are liable to become clogged with dirt, and so give bad results, even when much time is spent on cleaning the instrument before use. No agreement has yet been come to among operators as to the proper size of orifice to use, and results at present are usually relative and not absolute. Mr. Doolittle, chemist of the Philadelphia and Reading Railroad, has devised a viscosimeter on the principle of the torsion balance, of which we give a general view in Fig. 3. A steel wire, suspended from a firm support, is fastened to a stem, which passes through a graduated horizontal disk. A cylinder two inches long by one and a half inches in diameter is suspended by a slender stem to the end of the torsion wire and secured by a small thumb-screw. The oil is kept at a uniform temperature by being surrounded by a bath of water or paraffin wax. To start an experiment, the wire is twisted three hundred and sixty degrees by means of a knob at the top, and the cylinder then rotates in the oil by virtue of the torsion of the wire. The greater the viscosity of the oil, the greater will be the resistance, and hence the retardation. This retardation is a delicate measure of the viscosity of an oil which is expressed by the author in degrees of retardation per complete arc.

In order to secure freedom from error, two tests are taken—one by rotating the wire to the right, and the second to the left. For very accurate work, of course, it is necessary to determine the resistance in air and the resistance of the wire itself. These are readily obtained by first allowing the cylinder to rotate in the air and finding the amount of retardation under these circumstances. This gives a factor which is constant for a given instrument, and is deducted from the readings obtained in each experiment. The two advantages which this instrument possesses over other forms of viscosimeter are its independence of the gravity of the oil and of any reasonable amount of dirt which may get into it when in use.

Further experience has shown that, although the best method for expressing the viscosity where any one instrument is concerned is to take the number of degrees of retardation between the first and second complete arcs, where different instruments have to be compared it is far too delicate. Two instruments cannot be made to show the same number of degrees of retardation throughout a wide range of viscosity, unless such care and exactness are taken in the manufacture of the instruments as would add greatly to their cost. To obviate this difficulty each instrument is now standardized against pure cane-sugar solutions, the viscosity being expressed in the number of grammes of sugar contained in 100 c. c. of the sirup at 60° Fah., which will give the retardation designated at 80° Fah. These readings are obtained by taking a number of solutions containing known amounts of pure cane sugar and determining the retardation of each.

A curve is then plotted on a piece of ruled paper, the number of grammes of sugar in 100 c. c. of the different sirups representing the abscissæ and the degrees of retardation the ordinates. This curve enables the value of each degree of retardation to be interpolated in terms of pure cane sugar, and in this way a table of viscosities is drawn up and furnished with every instrument. Such a table renders the results obtained by different instruments strictly comparable.

Experiments with sugar solutions have shown the influence which specific gravity has on the determination of viscosity when made by the class of instruments which allow the liquid to flow through an orifice, the results being expressed in the number of seconds required to empty the vessel. The viscosity on the torsion viscosimeter of a certain oil having a specific gravity of 0·9 was found to be 86·4. A sugar solution was then made showing exactly the same viscosity, and its specific gravity was found to be 1·4. These two liquids having identically the same viscosity as shown by the torsion viscosimeter, but differing in specific gravity, were then run through a Saybolt viscosimeter. The oil required 35¼ seconds, while the sugar solution ran through in 30¼ seconds, thus showing that the difference in specific gravity caused an error of five seconds on the latter instrument by forcing the sugar solution through the orifice faster than the oil. To demonstrate still further the presence of this error, the viscosity of an oil of 0·9 sp. gr. was ascertained to be 35¾ seconds on the Saybolt instrument. A sugar solution was then made which gave exactly the same figure on the same viscosimeter, showing a specific gravity of 1·48.

The viscosity of these two liquids was then taken with the torsion viscosimeter, when it was found that the oil showed a viscosity of 86·8, while the sugar solution gave 91·8. In other words, it was necessary to make a solution of sugar of decidedly higher actual viscosity than the oil, in order to overcome the error due to difference in specific gravity. From this it would seem evident that the viscosity, as determined by any instrument based on the principle of allowing the liquid to flow from a receptacle through an orifice, has a very appreciable error due to the specific gravity of the liquid.

*Rideal and Youle's Viscosimeter.*—Dr. S. Rideal and W. E. Youle have also drawn attention to the fact that methods for determining the viscosity of liquids, based on the time of flow out of a burette, give misleading results unless special precautions are adopted. In a paper read before the Society of Chemical Industry (vol. x., No. 7), they discuss this subject at some length and describe a modified form of the apparatus devised by Slotte, which gives readings of viscosity of absolute value. Slotte's instrument consisted of two bulbs connected by capillary tubing. The bulbs were practically of the same capacity and were fitted with tubes, so that the liquid to be examined could be sucked over from one bulb to the other and back again. The capillary tube was continued upward into the first bulb for half its diameter, so that no correction is required for the effect due to gravity upon the liquid in the second bulb. The apparatus employed by Dr. Rideal is shown in Figs. 4 and 5 (for which we are indebted to the Society of Chemical Industry). It consists, as will be seen, of a bulb with an upper and lower constriction, to which is attached a length of capillary tubing $l$, which is prolonged by very wide tubing into a bottle holding the liquid to be examined.

By means of a water pump a large bottle is partially exhausted of air, the pressure being indicated by a gauge, and this reservoir is used for drawing the liquid up through the capillary tube until the bulb is filled and then down again until empty, by changing the connecting tubing. The time taken for the liquid to pass between the two constrictures is called the emptying and filling time respectively. The absolute viscosity, or "innere reibung," is given by the formula,

$$y = k \times g \times h \times d \times t$$

where $k$ is a constant for the instrument used, $g$ is gravity in C. G. S. units, $h$ the mean height through which the liquid passes, measured in centimeters, $d$ the density of the solution, and $t$ the time in seconds. The constant, $k$, depends on the dimensions of the instrument, and is equal to the value of the expression

$$\frac{\pi r^4}{8 l q}$$

where $q$ is the volume of the bulb in cubic centimeters, $l$ the length of the capillary tube in centimeters, and $r$ its radius. Instead of taking the dimensions of the apparatus and finding the value of $k$, one can find the time taken for water to flow out of the apparatus, and then using Poiseuille's value for water, the value for $k$ is determined indirectly. With very viscous solutions it is necessary to work under diminished pressure, as indicated above, if time has to be considered. Under these conditions, if HD represents the height and density of the mercury column in the pressure gauge, the formula becomes

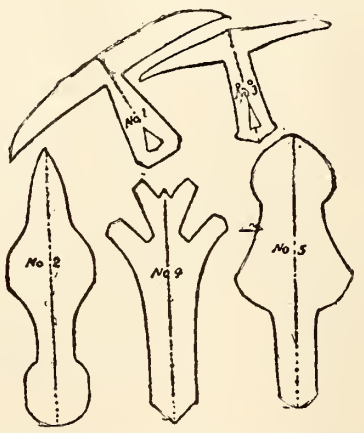
$$\eta = k\, g \left\{ \frac{t_o + t_t}{2} (\mathrm{HD} - hd) \right.$$

For very exact results, a correction for the kinetic energy in the liquid has to be applied when the rate of flow is rapid, but if the time is considerable, then this correction may be neglected. The instrument works well with oils, but was first used for determining the viscosity of gum solutions.—*Industries.*

## PAPER BIRDS.

The possibilities of home made amusement have been recently considerably extended by an invention of Mr. William A. Eddy, of this city. Mr. Eddy, with no other materials than a piece of paper and a paper of pins, has succeeded in making an aeroplane which flies with considerable success. This was only a few days ago, and now all Mr. Eddy's friends and acquaintances down town spend their luncheon hours in snipping out designs in paper, balancing them with pins, and sending the impromptu birds fluttering about in the air.

Anybody can make an aeroplane, although probably no one but a man who, like the inventor, has studied aerostatics for years would have thought of so simple a construction as the present one. There is no patent upon the invention, nor will there be one, because of its simplicity and the ease with which the floaters can be constructed. The original paper aeroplane is that numbered 1 in the illustration. Take a piece of light




paper about six or seven inches wide, cut it in the shape of the illustration, crease it lightly down the middle, weight it by sticking two pins through it in the places indicated by the dots, then stand on a chair and drop it. Instead of fluttering clumsily to the floor, it will go forward in a long, graceful swoop, and light gently at the other side of the room.

Now pick it up and slightly bend one of the wings. This time when liberated it swings gracefully around a circle, then circles again, reaching the floor after a course describing a perfect spiral. Bend the other wing and it circles in the opposite direction. This aeroplane is built after the model of the albatross, whose wing measurement is six times its length. It is known that the albatross can beat against the wind without motion of its wings, and Mr. Eddy thinks that some day an aeroplane that can do the same will be made. In the office of Coombs, Crosby & Eddy, at 78 South Street, is a big porter named Mike Collins. Mike was immensely interested in the aeroplane. Finally he ventured to ask for the loan of it to make one himself. The next day Mike appeared triumphant.

"I've cut a hole in my bird," he announced, "and sure he flies elegant and flutters his wings."

Mike showed the design numbered 3, and dilated on its merits. By noon every porter in the place had a "bird" of his own, and when the original inventor went down in the storage room to try a new design he found the men perched on bales and boxes challenging each others' "birds" to a race.

"I'll match the Pride of Erin agin' any bird that flies paper wings," announced one.

"I'll go you from here to the corner for a dime," responded another. "Here's backin' the American Eagle against the field."

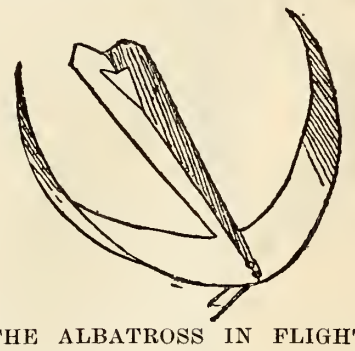
"White Wings is in that." "I'll enter the Tailless Wonder." "Make way for Skyscraper."

There were a dozed entries in no time, all the aeroplanes being built on the same general plan, with minor variations in cut and weighting. It was an exciting race, but all the "birds" tended to curve, and only the "Tailless Wonder," a very large albatross, cut sharp behind, reached the corner. The contest suggested to Mr. Eddy that a flat aeroplane without wings would go more directly; so he constructed one on the plan numbered 2. Some of his friends to whom he showed it trifled with its shape until they evolved number 4, which is not so rapid, but very graceful, and with a decided tendency to exploration in nooks and corners. Then Porter Mike took a fresh hold and carved out the peculiar-looking bird seen in illustration 3.

This one did peculiar things, so he perforated it and made it still more eccentric. Now he's hard at work making new experiments on this general design, and expects to turn out something great presently. The other porters declare that if all Mike's prophecies come true, he'll construct a paper bird that will not only fly to order, but will sing 'Hail Columbia" in time to the fluttering of its wings. Another good design is number 5, which is a rapid flier. It goes best when weighted with one very large pin close to the head. By perforating any of these aeroplanes they are made more steady, and if the perforations are small they seem to add to the buoyancy.

The designs given are a few of the very many made by Mr. Eddy and his friends. Mr. Frank J. French, of the *American Engineer and Railroad Journal*, has a fine assortment and is constantly making new experiments. All over the office buildings down town the idea has taken hold, and sailing these toy air ships bids fair to be the popular amusement of the day for business men. There are those, however, who look on it with suspicion. A few days since Mr. French and a *Sun* reporter went to the Boreel building on Broadway to try some of the toys from the seventh floor. A number of interested spectators gathered in the different galleries to watch the graceful course of the paper birds.

An albatross was first set off. It started with a long swoop across the open space, curved to the wall and



THE ALBATROSS IN FLIGHT.

fluttered along undecidedly; then made a dash for a pretty typewriter on the fifth floor, who put out her hand to catch it. But the aeroplane was not to be ensnared in beauty's net so easily. It wheeled, swept across the space again, made a beautiful long curve, and sank to the floor. After it, like a hawk after a pigeon, came a big "diver," one of the broad flat aeroplanes without wings. It reached the floor about the same time as the albatross, and fell at the feet of a middle aged man, who stopped abruptly and regarded it with suspicion. Turning his eyes upward, he beheld another one approaching. Then he went and called the janitor, who came in a hurry just as two more birds fluttered into one of the galleries, to the great delight of the spectators.

The janitor is a man without scientific instincts, but with a fully developed sense of his own importance. He examined one of the fallen birds, touched it with his foot, picked it up gingerly as if in fear that it might bite, and pricked his finger on the pin. Hastily dropping the bird, he climbed into an elevator and ascended to the seventh floor, where he found Mr. Eddy sending down more fliers. Fully impressed with the belief that the paper toys were in some occult way a menace to the building in his care and custody, he insisted that Mr. Eddy depart at once. In vain were the expostulations of the spectators. To their remarks and to all the bird flier's explanations he returned only abuse. In fact, he became very much excited and threatened to call in his assistants, the owner of the building, and the police. Then he rushed out to look for an officer, and rushed back again to make sure that during his absence one of the dreaded and mysterious paper things hadn't exploded and torn down the building. When Mr. Eddy and the reporter left the little janitor was furiously rushing about in concentric circles as if he expected by some magic process to evolve a policeman from the center. Mr. Eddy remarked that it was one of the incidental persecutions to which science was subjected, and that next time he would get permission of the owner of the building.

Thus far the paper aeroplanes have merely served as amusement; but Mr. Eddy believes that in their de-

velopment they will eventually solve the problem of aerial navigation. Experiments will soon be made in sending large aeroplanes down from a kite. When a motive power sufficient to hold a large aeroplane stationary against a head wind can be found, then, he says, the contrivance can be so weighted as to be lifted by the wind, and once lifted the weight can be shifted forward, and the machine swoop gracefully along in whatever direction is desired, as the paper birds do. This, he says, is still many years off. Meantime the little papers make an amusing and interesting toy on which numberless variations can be made. Get out your paper and shears and pins and try it yourself.—*N. Y. Sun.*

[Continued from SUPPLEMENT, No. 949, page 15174.]

## THE METHODS OF TESTING FATS AND OILS.*

By DR. ERNEST MAILLIAU, Director of the Government Testing Laboratory at Marseilles, France.

### FLUID VEGETABLE OILS.

*Olive Oil.*—Olive oil, like other vegetable oils, is a mixture of neutral glycerids, olein, stearin, palmitin, etc., and a variable quantity of free fatty acids. It is the edible oil *par excellence*, and the south of France owes a portion of its prosperity to the cultivation of the olive tree. This culture is to-day almost precarious in certain countries, though the consumption continually increases and olive oil always enjoys the just title of uncontested superiority. We can only attribute these remarkable results to the adulterations made for the purpose of selling under the name of olive oil, seed oils, or adulterated olive oils. We would be easily freed from these adulterations if chemists had at their disposition absolutely sure means to recognize them. Unfortunately the similarity of composition and reaction of the various vegetable oils render the demonstration of their presence extremely difficult. In face of the prejudice caused by adulteration, the greatest efforts have been made to solve the problem, and although the results have not been sterile, they have not yet reached a satisfactory solution. It is necessary to say that if certain adulterators succeed in selling seed oils disguised as olive, they reverse the problem for the chemist by making him seek olive oil in seed oil. I may remark that the fraud is not always so great. Very often the proportion of seed oil is not higher than 10 per cent. Consequently, for our methods of analysis to be considered absolutely good, they must give results without recourse to comparisons which are satisfactory to show 5 per cent. in a mixture. Under these conditions we will be certain to discover adulteration when made in the proportion of 10 per cent.

Let us rapidly review the general processes for the recognition of arachide, sesame, cottonseed, and poppy oils in olive oil; and we must acknowledge that none of them demonstrates less than 10 per cent.

*Specific Gravity.*—The specific gravity of olive oil varies from 0·915 to 0·918; we have 0·917 to 0·918 for undecorticated peanut, 0·921 for decorticated peanut, 0·923 for sesame, 0·921 to 0·924 for cottonseed oil, 0·924 for poppy oil. These variations of density in the olive oil do not allow us to recognize a mixture with any degree of certainty.

*Action of Nitrous Fumes.*—When taken from the water bath, if the oil contains a fairly large proportion of peanut oil, it will appear wine red. Pure olive oil is, on the contrary, lemon yellow. When taken from the cold bath a complete solidification is observed with pure olive oil, which has the appearance of very light fresh butter; with a mixture of 15 per cent. of all other oils there is no solidification. This method gives good means of detecting peanut and poppy oils in edible oils, but is of less use when applied to oils used for industrial purposes, which may not solidify, though pure.

*Sulphuric Saponification.*—The rise of temperature of olive oil is 35°; the relative, 94°. A rise of temperature above 35° usually indicates adulteration. Equal or lower results do not absolutely indicate purity, because certain pure olive oils give only 31°, 32°, and 33°, and, in consequence, after the addition of seed oil, show only 34° to 35°.

*Indices.*—The iodin number varies from 80 to 85, and in a certain measure helps us to discover seed oils. It likewise offers us a quantitative method with a mixture of known oils. The variations in composition of the same oil vitiate its sensitiveness for determining mixtures from 5 to 10 per cent.

We will not mention the other general processes, but will dwell particularly on the special reactions which characterize the presence of three oils most frequently used to adulterate olive oil, to wit: peanut, sesame, and cottonseed.

These processes have a much greater analytical value than the general ones, for if in the course of analysis we find unsatisfactory results with the latter, we can detect adulterations with certainty by the former.

*Examination for Peanut Oil.*—The density is almost the same. The sulphuric saponification, and above all the Cailletet process gives us good results, but only the presence of arachidic acid $C_{22}H_{44}O_2$ (melting point, 75°) allows the sure recognition of the presence of peanut oil. We have adopted, with slight modifications, the method of Renard. Twenty grammes of the oil are saponified by 20 cubic centimeters of a caustic soda solution of 36° B., diluted in 100 cubic centimeters alcohol 90 per cent. The soap formed is precipitated by a 50 per cent. solution, in alcohol, of lead acetate, which must be neutral. After complete precipitation, decant while warm, and wash the residue with alcohol, which after being ground in a mortar is agitated with 200 cubic centimeters of ether This operation is repeated three times to remove the last traces of lead oleate soluble in ether. The residue is then put in a porcelain dish containing two or three liters of distilled water and 50 cubic centimeters hydrochloric acid. When decomposition is complete the solution is decanted and the fatty acids washed with distilled water, after which they are dried in an oven to remove the last traces of water, when they are dissolved in 40 cubic centimeters of 90 per cent. alcohol. A drop of hydrochloric acid is added and the mixture chilled to 15°. Peanut oil gives a generous deposition of arachidic acid crystals. These are washed twice, using 20 cubic centimeters each time of 90 per cent. alcohol, then three times with 20 cubic centimeters each time of 70 per cent. alcohol, in which arachidic acid is completely insoluble. The washing is complete when a few drops give no residue on evaporation. The acids are warmed slightly and treated with boiling absolute alcohol. After filtration the alcohol is evaporated in the oven at 100°, till the weight of the residue remains constant. If the melting point of the residue is between 73° and 75°, we can affirm the presence of peanut oil. We must be sure of the freedom of the fatty acids from all traces of oleic acid, which prevents their crystallization. This elaborate but truly scientific process must be carried out only by skilled hands.

*Examination for Sesame Oil.*—To recognize sesame oil in olive oil we can use the specic gravity, the sulphuric saponification and Cailletet process, but especially the method which we use in our laboratory, and which consists of the reaction of hydrochloric acid and sugar upon the fat.

We do not operate on the glycerid, but on the derived fatty acids. If the oil is operated on directly, we can obtain a red or pink coloration with a perfectly pure olive oil. I have frequently observed this coloration in my laboratory with olive oils from Tunis, Algiers, Molfetta, Bitonto (Italy), and more rarely with those from Provence. This coloration comes from the coloring matter dissolved in the juice which flows out along with the oil from the presses. This can be shown by treating the separated juice with hydrochloric acid and sugar, with which it gives a coloration exactly resembling that given by sesame oil. It is, therefore, of the highest importance to work with pure fatty acids, according to the process I am about to describe, and which has been called the Maillian process.

*Method of Operating.*—We saponify fifteen cubic centimeters of the fat under examination with ten cubic centimeters of the solution of caustic soda, 36° B., with the addition of ten cubic centimeters ninety-two per cent. alcohol. When the boiling mixture becomes clear, we add 200 cubic centimeters hot distilled water and boil to expel the alcohol; then decompose with ten per cent. sulphuric acid. The fatty acids are removed from the surface in the pasty state and washed by shaking in a test tube with cold distilled water, after which they are heated in an oven to 105°. When the greater part of the water is eliminated and they commence to melt, we pour them on half their volume of pure hydrochloric acid, which has been saturated in the cold with finely pulverized sugar. The mixture is shaken violently in the test tube. The presence of sesame is always distinctly indicated by the rose or red coloration of the acid solution; other oils leave the acid colorless or communicate to it a slightly yellowish tinge.

This reaction is extremely delicate and permits the sure recognition of the presence of one per cent. of sesame oil, not only in olive oil but in all fatty mixtures, as well as in soap.

This process was presented before the Academy of Sciences by M. Debray, February 20, 1888, and was awarded the gold medal of the Societe d'Encouragement. (Report of M. Muntz, in the name of the Agricultural Committee, February 20, 1889.)

*Examination for Cottonseed Oil.*—Until recently the detection of cottonseed in olive oil was considered impossible, and accordingly, the different scientific societies and several chambers of commerce promised great prizes to the inventor of a process which would detect this adulterant.

Two methods were proposed simultaneously—one by M. Bechi, the other by myself. These two processes, which at first sight appear quite analogous and based upon the same reaction, differ completely from the scientific standpoint, as well as in the exactness of the results obtained. M. Bechi has based his process upon the direct action of silver nitrate upon the oils. As long ago as 1878, we made some experiments with M. Puget of a similar nature, and the uncertainty of the reactions led us to abandon them entirely.

M. Bechi's process possesses the serious inconvenience of causing us at times to reject as adulterated, oils which are absolutely pure, and thus work injustice and create a considerable prejudice against the firms which have sold them. From results obtained at the Institut National Agronomique of Paris, as well as in other laboratories, a deep coloration has been found with oils absolutely pure. Outside of these inconveniences, which are sufficient to cause us to throw it aside, it has a defect of being based upon a coloration having no well-defined chemical character, and it produces effects with different substances, the action of which it is impossible to explain. The use of colza oil has the serious fault of bringing into the reaction a second oil which may be impure and completely vitiate the results. Finally, the conclusions reached by the Italian scientific commission, instituted at Rome by act of the ministry to study the Bechi process, show that it is not certain on quantities of less than fifteen per cent. It solves the problem of finding less than ten per cent. no better than the Cailletet process, which shows the presence of fifteen per cent. The same commission declared also that olive oil containing glycerin, free fatty acid, formic acid, acetic acids, does not give a sure reaction with the Bechi reagent. Now, since all olive oils contain free fatty acid, from several tenths of one per cent. for virgin oil to 100 per cent. in some industrial oils, what conclusions can we reach?

The Bechi process will give, from fifteen per cent. up, a brown coloration of variable intensity, but in oil containing cottonseed oil, which is fresh and well refined, the only sort used for edible purposes, we have a very weak reaction; while with an olive oil perfectly pure, but containing organic or mineral matters in suspension or solution, which have an action upon the reagents, we should have a pronounced coloration.

That is why I gave up these uncertain and variable results obtained in 1878 and studied the action of the nitrate of silver, not upon the oil itself, but upon the products of saponification derived from it. The results obtained exceeded my expectations, and have been published by the press as the Mailliau process.

*Mailliau Process, Mode of Procedure.*—In a porcelain dish of 250 cubic centimeters capacity, fifteen cubic centimeters of the oil to be investigated are heated to about 110°, then there is slowly poured on the oil a mixture of ten cubic centimeters of a solution of caustic soda of 36° B. and ten cubic centimeters of alcohol of 90° B. When the mass boils it becomes clear and homogeneous; 150 cubic centimeters of hot distilled water are added and boiling continued to expel the alcohol. The fatty acids are displaced with ten per cent. sulphuric acid solution added in slight excess, and the pasty acids immediately collected with a small platinum spoon. They are washed by shaking several times in a test tube with an equal volume of cold distilled water. The drops of water are drained off and they are then poured into a tube 2·5 centimeters in diameter and 9 centimeters long; 15 cubic centimeters of alcohol ninety-five per cent. and 2 cubic centimeters of three per cent. nitrate of silver solution are added. The tube is protected from the light in the water bath at 90° C. until about one-third of the alcohol is expelled, which is replaced by 10 cubic centimeters distilled water. The heating is continued a few minutes and the coloration of the insoluble fatty acids is observed. *The presence of cottonseed oil in any proportion whatever causes a mirror-like precipitate of metallic silver, which blackens the fatty acids of the mixture.*

The members of the agricultural committee, composed of the greatest savants of France, MM. Pasteur, Eug. Tisserand, Boitel, Chatin, Heuge, Hardi, Rissler, Schloesing, Ronna, Lavaland, Muntz, Prillieux, Maret, Hon. Baron Thenard and Liebaut, after having tested the process on 128 samples from different provinces, have had the kindness to confer upon me the gold medal for this method of analysis, and I will take the liberty to present the conclusions of their secretary, M. Muntz, director of the laboratories de l'Institut National Agronomique: "The preliminary saponification applied to the examination of fatty matters constitutes a new method on which we can confidently rely, not only in the analyses of edible products, but also of those used for industrial purposes and also for soaps." (February, 1889.)

Before proceeding with this monograph, it is, of course, well understood that the same processes can be used for the detection of peanut, sesame and cottonseed oils, in all other fatty mixtures.

*Peanut Oil.*—Peanut oil, apart from the arachidic acid which it contains, presents no special characters, as you can observe by examination of the chart upon which are indicated its physical and chemical properties.

*Sesame Oil.*—The purity of sesame oil may be demonstrated by shaking 10 cubic centimeters of oil, first with five drops of sulphuric acid of 53° B., then with five drops of nitric acid of 28° B. The oil undergoes a progressive change of color through various shades from light green to red. The final red coloring matter obtained by this oxidation process turns yellow by the action of alkalies and returns to its original color with acids. This curious phenomenon does not take place with other oils, but is obtained sometimes when working on sesame oils slightly adulterated; besides, the industrial oils from hot pressing, though pure, may give negative results. I have devised a rapid process, especially applicable for the recognition of castor oil in the industrial sesame oils.

*Mailliau Process.*—For the rapid identification of castor oil and sesame, ten grammes of the oil are shaken up with four drops of sulphuric acid of 66° B., a drop of nitric acid of 40° is added and shaken violently. Pure sesame oil blackens immediately, while that containing castor oil remains turbid yellow.

*Cottonseed Oil.*—Concerning this oil, from a chemical standpoint, we have nothing particular to say. From the industrial point of view we may state that this product becomes more useful every day. Its cheapness allows everybody to use it, and this fatty material daily augments its important place in the markets of the world.

We will pass rapidly over the drying oils, poppy seed, linseed, walnut, cameline, over those of the cruciferæ, colza, rape and mustard, as well as the oils of the sweet almond, hazel nut and castor, the properties of which are shown upon the chart.

I will take the liberty, however, of mentioning a rapid process which I have devised for detecting the presence of castor oil in other oils. It is well known that the oils in general are soluble in petroleum ether, while castor oil, which distinguishes itself by its solubility in alcohol, is likewise remarkable for its insolubility in petroleum ether. Unfortunately this insolubility disappears at the ordinary temperature when a soluble oil is adulterated with a small proportion of castor oil.

It is only necessary to demonstrate its insolubility by shaking in a test tube one volume of the oil to be examined with two volumes of petroleum ether, and cooling the mixture to —16° C. At the end of a few minutes the mass coagulates, and the oil separates if castor oil is present, while the liquid remains homogeneous if it is pure. This phenomenon is especially curious, because it will be noted that the freezing point of castor oil unmixed with petroleum ether is much lower than that of most other oils.

### SOLID VEGETABLE OILS.

*Cocoanut and Palm Nut Oils.*—The production of these oils, which is continually increasing on account of their extensive use in the manufacture of soap during the last few years, has been made the object of several adulterations. Independently of the general chemical and physical character of these oils, as well as the sulphuric saponification which I have mentioned, we can employ with good results the determination of the saturation equivalent with normal caustic soda solution.

These oils, containing a greater amount of the lower fatty acids, require for their saturation a larger quantity of sodium oxide. To recognize these oils, it is only necessary to determine the number of cubic centimeters of normal solution required for the saturation of five grammes of the pure fatty acid, viz.: Cocoanut oil, 24·1; palm nut oil, 22·5; while the average of the other liquid oils is seventeen to eighteen cubic centimeters only. This process presents some inconveniences, especially when trying to discover adulteration in small quantities, because it must be noted that

* Read at a special meeting of the Chemical Section of the Franklin Institute, June, 1893.—*From the Journal.*

the adulteration of these oils is practiced only within certain limits, otherwise their appearance would lead to its detection. Besides, when an oil is made from old or spoiled seeds, the saturation is a little less.

Since the detection of adulterations in these oils depends on variations of a few tenths of a centimeter which might be caused by variations in quality of the oils themselves, or the method of operating, it is necessary to be very circumspect in the use of this truly scientific process.

With palm nut oil this error might be greater, because it is customary to balance the low saturation of the seed oils by the addition of cocoanut oil. As, for example, five grammes of fatty acids from a mixture containing forty-five per cent. of palm nut oil, forty-five per cent. cocoanut oil, and ten per cent. peanut oil, require precisely 22·5 cubic centimeters normal solution for their saturation.

*Iodin Number.*—This determination is very useful because these oils, being very rich in saturated acids, absorb much smaller quantities of iodin than most other oils. For example, peanut gives ninety-seven, while cocoanut and palm nut show only nine to sixteen. Unfortunately, this difference of seven between the maximum and minimum throws us out of the way for small quantities of admixture, so much so that different authors fail to agree upon the average variation; some giving eight to nine only, while we are accustomed to find from thirteen to fifteen.

To recapitulate, this process, which if it gave constant results would be excellent, fails to give sufficiently accurate indications to detect adulteration of cocoanut oil when in small proportions. It is worse with palm nut oil and of no value to distinguish between the two.

Continuing our investigations in another direction, we have fortunately found a process which gives constant results when used upon these oils after a preliminary neutralization.

We have discovered that cocoanut and palm nut oils are entirely soluble in absolute alcohol. At a temperature of 30° to 31° C., the former requires two volumes and the latter four volumes for complete solution.

It is a curious phenomenon that the smallest addition of vegetable or animal oils destroys this solubility in the same quantities of absolute alcohol. The solubility of the mixture is not proportional to its composition, but the mixture acts entirely like a distinct body.

*Mode of Procedure.*—First operation: Twenty cubic centimeters of the oil are shaken in a test tube with forty cubic centimeters of ninety-five per cent. alcohol. This indispensable preliminary treatment may give certain indications. Oils soluble in ninety-five per cent. alcohol, castor and resin oil, etc., are thus discovered, while mowrah and karite oils give a milky turbidity to the alcoholic stratum.

Second operation: Five cubic centimeters of the neutralized cocoanut oil are measured with a pipette into a graduated test tube and ten cubic centimeters absolute alcohol added. The temperature is raised to 31°, the tube shaken violently for half a minute and then immersed in a water bath kept at a temperature slightly above that of the tube.

Pure cocoanut oil dissolves completely and the solution remains clear. Any addition of another fatty matter causes precipitation; the material in solution being in a state of molecular equilibrium, which is destroyed by the slightest modification.

Cocoanut oil containing palm nut oil precipitates when the proportion of the mixture amounts to twenty per cent.; below this the mass remains turbid.

The verification of palm nut oil is made in the same manner, only using twenty cubic centimeters absolute alcohol instead of ten, temperature remaining the same, 30° to 31°. Five cubic centimeters of palm nut oil containing twenty per cent. or more of cocoanut oil dissolves in fifteen cubic centimeters of absolute alcohol. In the same proportions pure oil does not dissolve, and the mixture remains turbid.

A mixture of cocoanut, palm nut and peanut oils, in such proportions that the oil would appear pure by the indices of saturation, would easily be discovered by this process.

If we work at a lower temperature, the proportion of absolute alcohol must be increased. For example, at 25° to 26° it is necessary to double the quantity; for five cubic centimeters of cocoanut oil, use twenty cubic centimeters of alcohol, and for the palm nut forty cubic centimeters.

The same method may be used to determine the purity of cocoanut and palm nut cakes by first extracting the oil by means of a solvent and then operating on it in the manner described.

This process, which I have had the honor to describe, when carefully executed, enables us to determine in a few minutes adulterations of these oils which might cause bad results in soap making, which employs hundreds of millions of kilogrammes per annum, and in agriculture, which uses the cakes for cattle food. This process was presented to the Academy of Sciences, October 12, 1892, by M. L. Troost, and has been the subject of a favorable report to the Minister of Agriculture.

Let us pass rapidly over palm oil, of which the principal chemical properties are not remarkable, except its partial solubility in absolute alcohol, which is ten per cent. Also we will pass over the mowrah, which, as I have already mentioned, is identified by the milky-white turbidity which it communicates to alcohol by shaking.

*Illepi Oil.*—This product, the titer of which is 52·5°, and cottonseed margarine, or stearine as it is called here, whose chemical reactions are the same as the oil itself, will not long detain us.

While closing the description of the solid vegetable oils, I wish to mention karite oil, which comes from the French province, Soudan, which I have been especially directed to investigate by the Chamber of Commerce of Paris and the chamber of the syndicate for the manufacture of soap and candles.

It was very important for us to know how to utilize the great forest which covers the largest part of French Soudan. It is composed chiefly of the wild acacia and the karite or butter tree. The natives collect the nuts which fall from the trees, crush the kernels, treat the pasty mass with boiling water, and skim off the fat which comes to the surface. This fat, which is solid at the ordinary temperature, is used as an edible butter.

Without speaking about the great uses to civilization of this product, I must mention its remarkable chemical properties. The fatty acids, having a titer of 52·5° C., combine with soda to produce an extremely hard soap. For candle making they would probably give better results after preliminary treatment to remove the resinoid matters which they contain and which hinder the crystallization of the fatty acids.

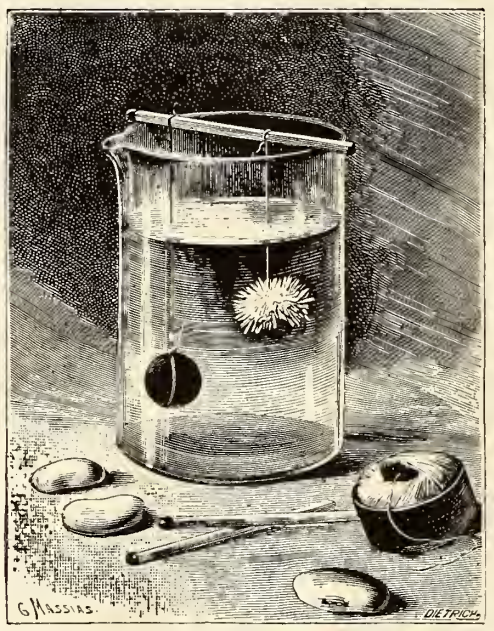
The presence of these resins lowers the saturation to 14·9, and, like the mowrah, this oil causes turbidity by shaking with alcohol. (Communication of M. Mailliau to the Société d'Encouragement of Paris in 1892.)

*(To be continued.)*

## EXPERIMENT ON THE CRYSTALLIZATION OF SULPHATE OF SODA.

During the course of some researches that I am making at the present moment upon the swelling of seeds I have been led to perform an interesting experiment that is easy to repeat with common objects. The following is the *modus operandi.* Into any vessel whatever put some water along with a certain quantity of sulphate of soda, which may be easily procured at any drug store. Stir for a certain length of time until it is judged that the solution is saturated—a fact that may be known by observing that the crystals no longer dissolve. A portion of the liquid is now decanted into another vessel, in leaving the undissolved crystals behind. Then attach a kidney bean to a thread and do the same with a non-porous object, such as marble, a pin, or a piece of glass. Upon the rim of the glass place a match horizontally and attach the two threads to it, so that the two objects that they support shall be immersed in the liquid.

In a short time we shall see emerging from the bean small crystals of sulphate of soda, which will increase and radiate in all directions, in rapidly growing in length. The non-porous object exhibits none of these phenomena. It looks as if the bean, which assumes the aspect of a sea urchin, had a very special partiality for the sulphate of soda and attached the latter to it; but, of course, this is so only in appearance. The explanation of the experiment is more commonplace:



EXPERIMENT ON THE CRYSTALLIZATION OF SULPHATE OF SODA.

the bean in swelling does not absorb the solution such as it is, but only the water that it contains, with a very little of the salt. The result is that, all around the bean, the solution, losing its water, becomes supersaturated and allows its crystals to deposit. It is a true evaporation in the interior of the seed.—*H. Coupin, in La Nature.*

## THE ESSENTIAL OIL OF LEMON.

By R. S. Ladell.

Many plants contain oily substances to which they owe their peculiar odor, and which can be obtained from them by distillation with steam. Many of the so-called essential oils contain terpenes or hydrocarbons represented by the formula $C_{10}H_{16}$; and it has been stated that the terpenes are often the chief constituents of the essential oils, as in the case of lemon and orange oils, etc. But it should not be forgotten that the oils of lemon and orange, as well as other essential oils, may be obtained entirely devoid of terpenes.

Geissler (*Pharmaceutische Centralhalle*, 1881) has described the terpeneless oil of lemon, and shown that it excels the commercial oil of lemon in odor, flavor, stability, solubility and strength. The true terpeneless oil of lemon, which is the subject of this note, is an oxygenated liquid of constant boiling point, specific gravity, and composition. Commercial oil of lemon has a specific gravity of 0·860 at 15° C.; the terpene known as citrene has a specific gravity of 0·850; while the *ordinary* terpeneless oil of lemon (*i. e.*, freed from citrene) has a specific gravity of 0·900. The ordinary terpeneless oil of lemon is really a mixture of several oxygenated compounds, but by fractional distillation a liquid has been obtained which has a constant composition, an exceedingly strong odor of lemon oil, a specific gravity of 0·962, a boiling point of 206° C., and a specific rotatory power of $[\alpha]_D = + 6·42°$. The following results were obtained on submitting this liquid to analysis: 0·5313 grm. gave 1·5135 grm. of $CO_2$ and 0·5617 grm of $H_2O$.

| | Found. | Calculated for $C_{10}H_{18}O$. |
|---|---|---|
| Carbon | 77·6 | 77·92 |
| Hydrogen | 11·8 | 11·68 |
| Oxygen | — | 10·40 |

The above figures correspond with the empirical formula $C_{10}H_{18}O$ for the *true* oil of lemon—that is to say, for the terpeneless oil of lemon of constant composition. This oil appears to be an isomer of borneol. Further investigations are in progress, the results of which will be published in due course.—*Chemical News.*

## SASSAFRAS TREES.

By Walter J. Quick, Columbia, Mo.

As being of some scientific interest, it is worthy our attention to note the marvelous growth that ten trees of the above well known variety have acquired here in Missouri—a growth that is so exceptional of this species that it has not been observed elsewhere in the United States.

The *Sassafras officinale*, of the order *Lauraceæ*, the laurel family, is very seldom known as little more than a shrub or bush and generally as growing poorly or not at all on fertile soil. In truth, it is looked upon as being in its native element in company with and growing on thin land. This is not a fact, but the opinion prevails since old and worn-out fields, depleted of their fertility in greater part, when abandoned, grow up to "brush," not the least profuse of which is the sassafras. It is a native of America and has been found in every State in the Union, growing much more abundant on poverty-stricken soil, but more luxuriant and larger in proportion, we conclude, as the per cent. of humus in the soil increases. In the poor, white clay lands of the New England States and some parts of Indiana, Kansas, and this State we have observed it growing where it seems to sprout profusely and does not reach a height of over 12 ft., usually 6 or 8 ft., while in the same States on richer land it will not be found in thick profusion, but scattered and attaining almost to the dignity of a tree in size.

Recently it was our pleasure to visit the beautiful farm of Mr. T. B. Hickman, near Columbia, Mo. During our stay we were shown the various interests of the owner, and our attention was summoned to some peculiar trees of the sassafras variety. Their difference from others of this species consists in their vigorous growth and extreme size, being the largest any one present had ever seen or of which we had in any way known. This preternatural development inspired us to investigation. They exhibited on measurement the surprising circumference of 80 to 82 in.—a diameter of over 26 in. As the bark is thick and rough, similar to walnut, the diameter of the solid wood is not likely this much, but fully 2 ft. By triangulation we ascertained the height to be about 55 ft., and the whole ten will not vary much from these measurements.

While there is very little indication of decay, as a matter of fact these trees are fully grown for this variety. Their location is very auspicious for the growth they have made, being the low, rich and moist soil of Bonne Famme creek bottom. The writer has never seen larger trees, and is unable to learn of larger specimens on this continent, with the exception of the species of sassafras of California and the western slope of the Rocky Mountains, known as *Oreodaphne Californica*, which attains a still larger size in "the land of big trees." The aroma from the leaves of this variety is more pungent: in fact, so much so as to occasion excessive sneezing, frequently during high winds. It has a greater reputation medicinally than ours, though the importance of the latter is by no means small.

Our *officinale* species has been introduced into England as *Sassafras laurus.* As is usual with anything imported, they appreciate it more as medicine than we do. A tree near the Royal Gardens at Kew has attained a height of about 50 ft., and is said to be over 110 years old. As there are no other figures given, we cannot compare the size with that of the Hickman trees, but the height is not so great.

Almost every country has one or more species of this tree, all said to differ in some characteristic from ours, but all having the same odor and similar aromatic, sweetish taste. But one country has larger trees. Those of New Zealand grow to a height of 100 to 150 ft. This tree appears in every clime, and is described as having "a large head of horizontal branches." The fruit is a small, black drupe, which is not palatable, but is eaten by birds. The sassafras oil of commerce is made from these seeds and the buds. The leaves of our species are very dark green, rather thick, broad, oblong and elliptical.

In Italy it is more like the American species than any other, and is known as *Sassafrasso.* The word comes from the Latin, *saxum*, a stone, and *frango*, I break, so named because it was believed that the use of the tea made from it would dissolve the gall stones of the bladder and prevent their formation.

In the Southern States sassafras grows to the size of trees, generally small, but very abundant. The air is said to be more pregnant with its aroma than further north, and it can be detected a great distance at sea. The bark seems to be more fragrant, too, when steeped.

Sassafras tea is very popular in many sections of the countries where the tree grows. The bark of the roots is kept everywhere for sale, for that purpose. In addition to its use as a table beverage it is employed as a tonic and constitutional stimulant. In those localities where the sugar maple tree is a native and abundant, a very delightful drink is made from the "sugar water," or sap and bark of the sassafras root. It makes the finest tea in the spring when the sap is forming, and is then drunk mostly to resuscitate the system, improving the appetite and aiding the digestion. It is also valuable for boils, pimples, and eruptions of all sorts, as well as for rheumatism.

The pith of the new growth and sprouts contains a gum or mucilage, used in eye medicines, as being important in reducing inflammation and granulations. This product is also prepared in the form of a drink for diseases of the kidneys, catarrhal troubles and dysentery.

In many localities there is perhaps no more popular farmers' remedy for disease of horses. It is administered by grinding the root bark to a powder and giving it in the feed, or by preparing a decoction with which the feed is mixed. Frequently the roots are placed in the horse's feed trough, and he is permitted to bark them himself, which he willingly does, apparently with much relish. In the spring it greatly improves his ap-

petite, strengthens him, and assists in shedding and sleeking his coat.—*Science.*

## HORTICULTURAL AND VEGETABLE NOVELTIES OF THE SEASON.

A RECENT number of the *Gardeners' Magazine* contains an illustrated article on this subject from which we make the following abstracts.

### AQUILEGIAS.

This interesting class of old garden flowers has not of late received any great attention at the hands of our own florists, but our continental friends patiently pursue their investigations and experiments, which

AQUILEGIA VERVAENEANA ATRO-VIOLACEA PLENISSIMA.

sometimes result in the discovery of a new species, the production of good hybrids or the fixing of an improved variety. MM. Vilmorin, Andrieux et Cie., Paris, are offering seed of a race of hybrids obtained by crossing A. chrysantha with A. cœrulea; the flowers are large and erect, and contain various shades of yellow, rose, violet, copper, and yellow. For every purpose this strain—hybride de cœrrulea variée—is extremely useful, and easily cultivated. The Parisian firm also offer a white variety of A. flabellata, which they recommend for pot culture and forcing. Chr. Lorenz, Erfurt, offers a handsome aquilegia, which has everything to recommend it but its name; we give an illustration of this novelty, which is catalogued as Aquilegia Vervaeneana atroviolacea plenissima. This form has large and very double flowers of a dark violet color; the foliage is handsomely variegated, and the habit is decidedly elegant.

### BEGONIAS.

All the firms which make begonias a specialty have this year introduced many excellent new varieties, and some distinct novelties. Messrs. J. Laing & Sons have among other fine double-flowered kinds, Duchess of York, rich rosy red, of erect habit; Duke of Fife, salmon pink, a handsome variety; Gigantea, enormous

BEGONIA SEMPERFLORENS, DUCHESS OF YORK.

salmon colored flowers; Mrs. Regnart, a grand double yellow, which attracted much attention at the last Temple show. Besides their large and excellent collection of named tuberous begonias, this firm have a unique collection of the handsome Rex begonias, including the recent additions, of which several have very highly colored leafage. Messrs. H. Cannell & Sons are well known as cultivators and raisers of new and meritorious begonias; a few of their best recent introductions are Hector, a grand scarlet flower of deep form; Lord Llangattock, with enormous velvety scarlet flowers; and R. B. Parsons, a remarkable plant of splendid habit, and bearing numbers of fine double flowers of a delightful shade of bright rosy pink. Fashion is a single variety of wonderful free habit, and has old gold colored flowers shaded with yellow. Mr. T. S. Ware, of Tottenham, has made vast strides in the improvement of begonias, and has this year some magnificent varieties, notably Elegans, which is a new departure in the carnation shaped forms, the edges of the petals are wavy and crisped, and the color is salmon pink shaded with yellow; Miss Jennie Fell is a charming addition to the camellia flowered section, and is of a rich crimson hue. Mrs. F. Fell bears the largest flowers of any we have seen, and these are an exquisite shade of salmon rose; Duchess of Teck is one of the finest double yellows. Duke of Teck, a particularly large and gorgeous crimson scarlet variety. Ada Allward is a handsome variety of a section which the Tottenham firm has devoted much attention to; the center is pure white surrounded by rich salmon. The illustration admirably depicts this variety. Picotee is another lovely new production, the ground color being pure white, while the segments are prettily edged with pink. One of the most elegant and pleasing begonias we have seen. Mr. J. R. Box, Croydon, has long been associated with the progression in begonias, and his new varieties show decided improvement. Mrs. Jenkins is a grand double yellow, distinct in habit and with large flowers; Lady Beatrice Herbert is a lovely double salmon pink, and Hon. Sydney Herbert is a broad petaled double form of deep rosy carmine color. A new begonia has been introduced by Messrs. J. Veitch & Sons, Chelsea, from the East Indies. It is a very dwarf species with beautiful small bronzy green leaves, like velvet, through which run the veinings, which are of a yellowish green color. This handsome stove begonia is named B. decora, and is well worth the notice of those who can accommodate it. Messrs. Sutton & Sons, while not behind in their selection of tuberous rooted begonias, have recently devoted a large amount of attention to the fibrous rooted semperflorens varieties, one of which—a charming variety named Duchess of York—we have the pleasure of figuring. The delicate carmine tinted flowers of this have attracted considerable attention of late. A companion novelty is Sutton's Coral Gem, which blooms profusely, being, when well grown, literally covered with rosy peach-colored flowers. The semperflorens begonias are remarkably free in blooming, and after being bedded out during summer they can be lifted and potted, when they will provide a display in a warm house during winter.

### DAHLIAS.

The taste for light forms of flowers has now become so fixed that the symmetrical florists' flowers which

SINGLE CACTUS DAHLIAS.

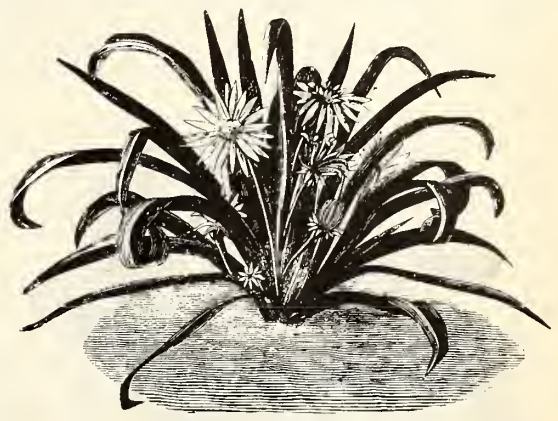
passed muster a few years back have now for indoor decorations to give place to elegant and graceful forms. Thus, in the dahlia we have retraced our steps, seeking for new things all along the path; the show dahlias are usually discarded for that purpose, but the cactus, decorative, pompon, and single varieties remain, and the less formal section has the greatest number of devotees. The illustration of the new single cactus dahlias we are enabled to give through the courtesy of Messrs. Dobbie & Co., Rothesay, who have been the introducers of this section, which originated with E. J. Lowe, Esq. These dahlias are less formal than the single kinds, and the colors, considering the short time Messrs. Dobbie & Co. have taken to develop them, are remarkably diverse and striking. This informality will be a detraction from merit in the opinion of many, but as we have indicated above, the taste for artistic outline and graceful habit has become so pronounced that to say their popularity will be great in the immediate future could hardly be called a prediction.

### DELPHINIUMS.

These superb hardy perennials have been brought to such perfection during recent years that one hardly deigns to look at the old varieties which decked our gardens ten or fifteen years ago. As the season comes round we look for the displays of delphiniums just as at a later period we look for chrysanthemum shows, but while to assist in the progress of the latter there are innumerable firms and numberless private growers at work, there are few who have worked to improve the delphinium. The improvement has nevertheless been made, and all who from time to time have had the opportunity of noting it, have marveled at the result obtained almost single handed by Messrs. Kelway & Sons, of Langport, Somerset; we would willingly divide honors, but there being no competitors, this firm carries off the palm. Blue in its multitudinous shades is the color most frequently met with now, but we hope that Messrs. Kelway & Sons will shortly give us some distinct color through the medium of the yellow D. Zahil they exhibited a year or two ago. A few of the new delphiniums offered this season are John Thorpe, a brilliant blue semi-double with white center very handsome; Geneva, sky blue and mauve with white eye; Kenneth, deep blue, with a black center; Ultica, deep violet and purple with darker center; and Burlington, plum color, edged with blue prettily relieved by the white eye. Washington is a handsome single variety, violet and plum color, white center.

### GAZANIA.

It is some time since any novelty has appeared in the now somewhat neglected genus of gazania, but we have



GAZANIA NIVEA.

now to record the introduction of a new speeies from Natal. Gazania nivea may be grown as a greenhouse plant or cultivated like many other half hardy plants, and placed out of doors in the summer time. The accompanying illustration given by the courtesy of Chr. Lorenz, Erfurt, Germany, affords a good idea of the plant's habit. It grows about one foot in height, and produces numerous large composite heads of flowers. The ray florets are broad and pure white, while the disk florets form a compact dark yellow center. Gazania nivea is worth the attention of all who desire to possess a novelty and wish to include a distinct new plant among their garden treasures.

### NICOTIANAS.

This year we have to record a variegated form of this striking and handsome half hardy plant. We first

NICOTIANA COLOSSEA VARIEGATA.

made the acquaintance of Nicotiana colossea variegata at the Ghent exhibition of 1893. This novelty is grown extensively at Messrs. J. Laing & Sons, Forest Hill Nurseries, and one of their plants is figured in the accompanying illustration. The several shades of green in the massive leaves contrast in a striking manner with broad creamy margins and the silvery patches which shade into gray and green. We have also observed a form of Nicotiana affinis with creamy variegated foliage, but so far as we have seen, it is less vigorous than the type.

### SAINTPAULIA IONANTHA.

For the opportunity of figuring this charming novelty we are indebted to Mr. Ch. Lorenz, of Erfurt.

SAINTPAULIA IONANTHA.

The plant combines in itself the appearance of a streptocarpus, a ramondia, and a gloxinia, it is a member of the large gesneracious family, and its flowers somewhat resemble a violet in form and color. Saintpaulia Ionantha was found on the Usambara Mountains, in East Central Africa, by Mr. Saintpaul Illaire, and will doubtless become popular, as many British firms are this season offering seed of it. This novelty requires similar treatment to that under which the beautiful streptocarpus thrives. The foliage is like that of a gloxinia, but smaller and very stout. The whole plant is dwarf, and flowers uninterruptedly the whole year through. The flowers are borne freely on short stalks, are dark blue or violet in color, but are rounder in outline, and flatter than those of Viola odorata. The fineness of the seed renders it necessary to warn intending purchasers to handle the packets carefully; sow the seed thinly, having previously watered the soil.

LOBELIAS.

Several new lobelias, varieties suitable for bedding purposes, have been brought forward this year. The finest and most distinct of these is doubtless Barnard's Perpetual, which has been described as the "finest lobelia yet raised." We give an illustration of this excellent novelty, of which Mr. William Bull, King's Road, Chelsea, holds the entire stock; the color is brilliant blue, with a patch of pure white at the base

LOBELIA, BARNARD'S PERPETUAL.

of the two lower petals, and the habit of the plant is all that can be desired. We have seen this on several occasions and can speak well of it. Messrs. W. Clibran & Co. include Golden Queen in their list of novelties. This is an effective golden foliaged variety, with pretty dark blue flowers. A distinct pure white flowered lobelia named White Ladie is in the hands of Messrs. H. Cannell & Sons. It is the result of many years' selection, and in everything save color is similar to the celebrated Crystal Palace Blue; White Ladie is stated to come true from seed, and this being the case, it will be eagerly sought after by those who have to propagate large stocks of white lobelias.

PRIMULAS.

Messrs. H. Cannell & Sons have a novelty of great merit and distinction in The Lady. This is a single white flowered form with yellow eyes to the blooms; the latter are borne in wondrous profusion in whorls, and these are freely produced, holding themselves in a

PRIMULA, THE LADY.

graceful manner well above the dark purplish green foliage, and thus we have a plant which in its way is unsurpassed in elegance and decorative value. The flower spikes when cut and placed in water are extremely useful by reason of their beauty and long duration. Having seen quantities of this novelty at Swanley, we do not hesitate to say that The Lady will commend herself to those of æsthetic tastes. Cannell's Eynsford White is remarkable for the purity of its whiteness, while the fimbriation of the overlapping petals is not equaled by any known form. Cannell's White is also a good single white, holding its flowers well above the foliage. The new single primula Snowflake, offered by Messrs. J. Veitch & Sons, Chelsea, is a valuable novelty; it is dwarf in habit, has fern-like foliage, while the flowers are handsomely fringed, of snowy whiteness, and have the smallest of yellow eyes.

VERBENAS.

These beautiful plants have apparently lost favor in the southern districts, and their successful cultivation has largely become a lost art. The amount of time expended upon beds planted with verbenas in years that

VERBENA COMPACTA COCCINEA OCULATA.

have long since past in pegging and training into order the trailing and straggling shoots will be remembered by many. Such time would have been saved and verbena pins would have been unnecessary had we but known such handsome forms as that illustrated as Verbena compacta coccinea oculata. We are indebted to Mr. W. Bull for the opportunity of figuring this novelty, the length of whose name might be disastrous were it not expressive. The compact habit is well shown, and it only remains for us to say that the flowers borne in large trusses are bright scarlet, with a large white eye.

ZINNIAS.

Given a good selection of seed, careful raising so as to avoid spindly growth, a well drained soil and a bright summer, then zinnias in any garden cannot be outdone for striking effect, neither are they excelled in brilliancy and gorgeousness of coloring by any other subject, not excepting the dahlias. Mr. William Bull offers improved zinnias of enlarged size and excellent shape; when the sun is shining upon the living flowers the latter present a dazzling combination of scarlet and gold, and these colors so elegantly mixed have suggested the name of the variety—Scarlet and Gold. When we remember that zinnias vary so largely it is worthy of note that this variety has been so far fixed that about seventy per cent. are said to come true from seed. Zinnia beds should always be well drained and the soil light and rich, otherwise much disappointment will follow. Messrs. H. Cannell & Sons are offering seed of the wonderfully fantastic Curled and Crested zinnias, which were introduced by Messrs. Peter Henderson & Co., of New York; these in their various colors, and also the diminutive Lilliput, with its interesting compact heads, are in every sense of the word novel.

CUCUMBERS.

The remarkable extension which cucumber culture has undergone of late years has quickened the activity of raisers, and as the result, important additions to the lists are made from time to time. Chief among the most recent introductions are: Bountiful, a remarkably fine variety, equally suitable for exhibition and the table; and Stourbridge Gem, a distinct variety of great excellence, being immensely productive, of high quality and very handsome. Both have been introduced by Messrs. E. Webb & Sons, and promise to attain a high degree of popularity. Sutton's Peerless is distinguished by its productiveness and handsome appearance, and is unsurpassed in delicacy of flavor. The fruits, under good cultivation, attain a length ranging from twenty-four to twenty-eight inches, are perfectly straight and with short neck.

LETTUCE.

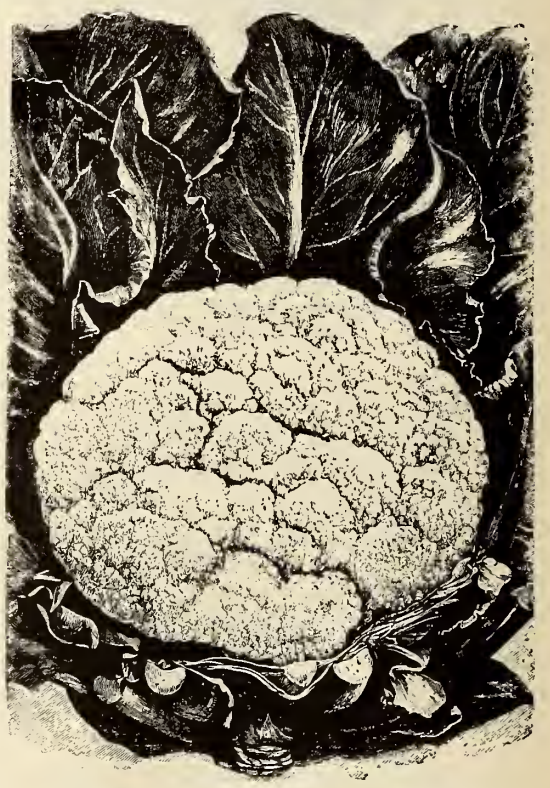
Our attention has been drawn to a distinct novelty in this vegetable, namely, the Oak-Leaved Lettuce, which is being offered by Messrs. W. Clibran & Son, Manchester and Altrincham. The illustration will convey to the reader a very good idea of the general appearance of this new comer. The shape of the leaves fully justifies the name of the variety, and this peculiarity does not detract from its usefulness. The Oak-Leaved Lettuce has a fine flavor, forms an early growth and stands well. Large Yellow Market is a new cabbage variety of considerable merit, inasmuch as its compact heads are unaffected by bad weather, while tenderness and flavor are all that can be desired. Messrs. J. Veitch & Sons have an excellent variety, Golden Queen, a pretty cabbage form with crisp golden

OAK-LEAVED LETTUCE.

leaves, which was certificated at one of the Royal Horticultural Society's meetings.

BROCCOLIS.

The improvement of these vegetables proceeds so slowly that really good additions are well deserving of a hearty welcome. Avalanche, raised and introduced by Messrs. E. Webb & Sons, is especially promising, for with finely formed, pure white, delicately flavored heads is combined a degree of hardiness considerably above the average. Sutton's Snow White is a most valuable addition to the varieties in use during the

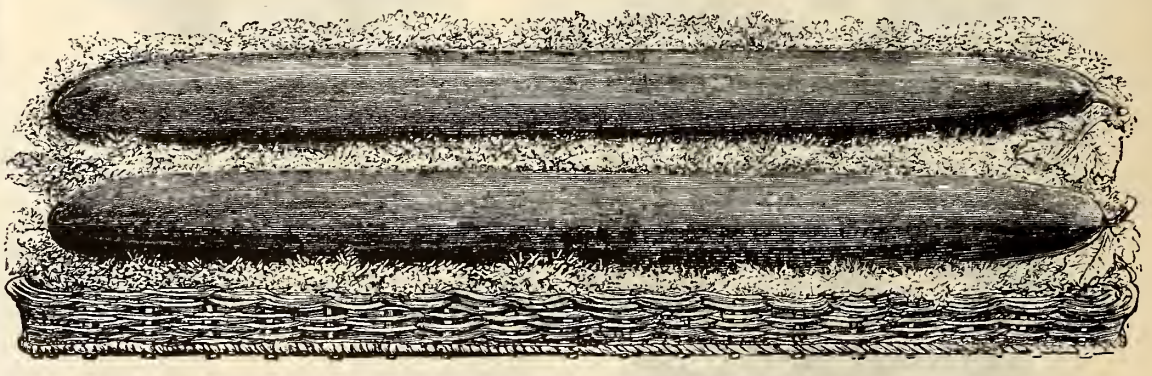


BROCCOLI, SUTTON'S SNOW-WHITE.

spring months. The heads are of good size, firm, pure white, and exceptionally delicate in flavor. The accompanying illustration renders a lengthy description of this fine novelty unnecessary.

MELONS.

As the result of the comparative facility with which new melons can be raised, many novelties are presented



CUCUMBER, STOURBRIDGE GEM.

to the public notice annually; but in consequence of raisers failing, as a rule, to thoroughly test their seedlings before submitting them to the Fruit Committee of the R. H. S. and other bodies, very few are found to possess sufficient merit to justify their being considered worthy of general cultivation. Among the few that have passed muster and are offered this season are some of exceptional excellence, and to these we shall briefly direct attention. Sutton's Scarlet and Windsor Castle, introduced by Messrs. Sutton & Sons, are noteworthy additions to the list. The first mentioned is a scarlet flesh variety raised by Mr. Tegg, of Bearwood, and has globular finely netted fruits of a rich golden hue and with deep red flesh, remarkable for its richness of flavor. Windsor Castle is a very dis-

tinct green flesh variety, fruits large oval in form with netted skin; the skin is deep green, rich and luscious. Beauty of Syon, introduced by Messrs. J. Veitch & Sons, was raised by Mr. G. Wythes, the able chief of the Syon House Gardens, and is a very valuable addition to the scarlet flesh varieties. The fruits are globular, with finely golden yellow skin, and the flesh is bright in color and rich in flavor. As indicating its high quality it may be mentioned that the variety was awarded a first-class certificate by the Fruit Committee of R. H. S. at the end of October, when, generally speaking, melons are not at their best. As shown by

MELON, BEAUTY OF SYON.

the illustration of a plant grown by Mr. Wythes, Beauty of Syon is well adapted for pot culture. Frogmore Seedling, also introduced by Messrs. Veitch, was raised by Mr. Owen Thomas, the Royal Gardens, Frogmore, and is a valuable addition to the white flesh section. The fruit is of medium size, has a yellow slightly netted skin and a white flesh, which is exceptionally thick and richly flavored. President, introduced by Messrs. E. Webb & Sons, is another white flesh melon of exceptional excellence. The fruits are of large size, oval in form, and the flesh is white, firm, rich and luscious. The plant has a good constitution and sets its fruits freely.

ONIONS.

Of late several improved types have been introduced, and as, without exception, they have a tendency to the globular form, we have an indication that raisers are beginning to appreciate the superiority of the globe to the flat types, because of the greater bulk obtained from a given area. One of the most important of the novelties is Sutton's A1, which stood high in the Chiswick trials last year, and obtained the distinction of three marks (× × ×), and was awarded a first-class certificate by Fruit Committee of R. H. S. in the autumn. The bulbs are semi-globular in form, handsome, very solid, and have a brownish skin, while the quality is very high. Veitch's Main Crop is a handsome onion, high at the shoulders and full at the base, and very heavy in proportion to its diameter.

ONION, "SANDY PRIZE" WHITE SPANISH.

The skin is of a pale straw color, and the quality good. As indicating the weight of the bulbs, it is of interest that Mr. J. Channery obtained twenty-five cwt. from 104 square yards, and that Mr. E. F. Crocker reports a crop of 2,008 pounds from five perches. Laxton's Sandy Prize is an excellent form of the White Spanish, selected by Messrs. Laxton Brothers, and has fullness both at the shoulders and the base. Southport Red Globe and Southport Yellow Globe are two extremely useful globular onions that promise to prove exceedingly useful for market supplies, as well as for the garden. In comparison with the best of the flat forms of the Blood Red onion, Southport Red Globe weighed, we found, exactly twenty-five per cent. heavier, a point of enormous imprortance to the grower for market. Cocoa Nut is an excellent addition to the globe-shaped onions, the skin yellowish green, and the bulbs remarkable for their solidity. The last three have been introduced by Mr. Deverill, and received awards of merit from the Fruit Committee of R. H. S. in the autumn.

POTATOES.

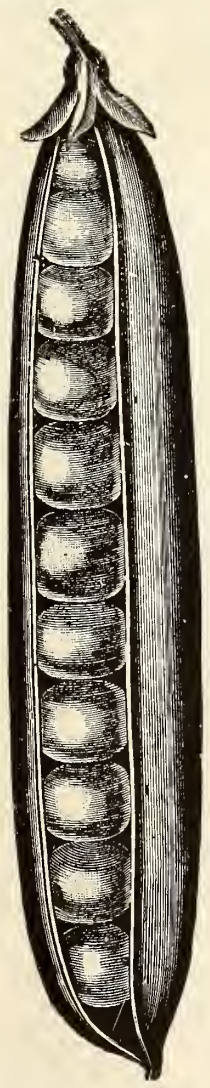
Prominent among the potatoes which had first-class certificates conferred upon them by the Royal Horticultural Society last year after trial at Chiswick is Jeanie Deans, a second early round introduced by Messrs. J. Carter & Co. The variety belongs to the second early section, and is a very heavy cropper. The tubers are large, round, or pebble-shaped, with a netted skin and white flesh, which is dry and floury when cooked; it should prove a good market variety. Fidler's Colossal, raised by Mr. Fidler, is a heavy cropper, and the tubers are large, long, and with rather rough skin; the quality when cooked is very high. Conference, raised by Mr. R. Dean, is a valuable main crop variety, the tubers pebble-shaped, with red eyes, and of high quality. Triumph and Windsor Castle, two valuable varieties raised by Messrs. Sutton &

POTATO, JEANIE DEANS.

Sons, were also certificated by R. H. S. after trial at Chiswick. The first named is a main crop variety, with rather long pebble-shaped tubers, which have a rather rough skin, and are of the finest flavor cooked. The second has a short, erect habit, and produces handsome tubers of an elongated pebble shape. Like Triumph, it is a heavy cropper and of excellent quality. Success, a white kidney sent to Chiswick by Mr. J. Aplin; Nellie Langtry, a pebble-shaped variety with yellow flesh, raised by Mr. H. Fletcher; Major T. Neve, a roundish white kidney, raised by Mr. H. Fincham, all of which received first-class certificates after trial at Chiswick, are deserving the attention of cultivators. Early Regent and Sharpe's Victor, which also obtained distinction from R. H. S. last year, are now so well known as not to require description.

PEAS.

Several noteworthy additions to both early and late peas have been made of late. The best of these comprise Sutton's May Queen, a distinct marrowfat pea, productive, and of high quality, and as early as Ringleader. This has been introduced by Messrs. Sutton & Sons, and was raised by Mr. Culverwell



PEA, GRADUS.

from a cross effected between American Wonder and Early Paragon; the height is about 30 inches. Sutton's Eureka is a valuable addition to the main crop varieties. The variety is robust in growth, immensely productive, the pods large, handsome, and well filled, and the peas bright green and finely flavored; the height is three feet. Very valuable also is Laxton's Gradus, a distinct wrinkled marrow, raised by Messrs. Laxton Brothers, of Bedford, which should prove of a high degree of utility. It is equal in earliness to William I., while the pods are as large and well filled as those of Duke of Albany, and the peas are large, bright green, and well flavored. Alderman, also raised by the Messrs. Laxton, is a promising main crop variety; it has strong, free branching habit, is immensely productive, and the pods are of the largest size and well filled. Each of the Bedford varieties has obtained the highest distinction from the Royal Horticultural Society after trial. Senator, raised by Messrs. Webb & Sons, and sent out for the first time last season, proved so exceptionally good that mention might with advantage be made of it. It attains a height of between thirty inches and three feet, and bears a profusion of curved, well filled pods. This promises to prove of much value for garden culture, as well as for the private garden. Veitch's Main Crop, introduced by Messrs. J. Veitch & Sons, is a valuable addition to the mid-season wrinkled marrows. The haulm attains a height of three feet, is robust and free branching, and the large, slightly curved pods are well filled, and the peas bright in color and of excellent flavor. It is one of the heaviest cropping varieties that has yet come under our notice.

## IRRIGATION BY THE USE OF WINDMILLS.

By B. A. MCALLESTER, Land Commissioner of the Union Pacific Railway.

AT the Interstate Irrigation Convention, held at Salina, Kan., on September 28, 1893, my attention was particularly drawn to the subject of pumping water for irrigation by means of windmill pumps. Several gentlemen were present from Garden City, Kan., who detailed, in a very interesting way, the results obtained in their locality by this means. Shortly afterward, in conversation with a gentleman from Julesburg, Col., I learned that one or two farms were being irrigated in the same manner in the vicinity of Julesburg.

It then became a matter of curiosity to ascertain the extent to which this irrigation, by pumping, has been practiced throughout the country, and I prepared and sent to each of our station agents and land agents in Nebraska, west of North Platte; Kansas, west of Wa Keeney; Wyoming, east and south of Cheyenne; and all of our agents in Colorado, New Mexico and Texas, a circular letter asking the names and addresses of any individuals whom they might know were pumping water for irrigation purposes. In response to these letters I secured in the neighborhood of two hundred names of parties located in western Nebraska, southeastern Wyoming, northeastern and east central Colorado and western Kansas. To each one of those parties I sent a letter asking the locality of their lands, number of acres irrigated, power used, whether wind or steam, cost of plant and cost per year of operation; depth and diameter of well, depth of water, whether or not the well could be pumped dry; diameter of stream coming from the pump, capacity of pump in gallons per hour, average length of time per year of running the pump and area and depth of reservoir. A large number of these letters have been returned with full and complete answers to the questions asked, and in many instances accompanied by enthusiastic letters advocating this method of irrigation.

While awaiting replies to these letters to the individual farmers, I submitted to one of the prominent wind engine pump companies a series of questions as to the capacity, cost, etc., of windmills and pumps. From the pump company I learned that one horse power will raise a 5 in. column of water 100 ft., a 6 in. column 70 ft. and an 8 in. column 40 ft.; additional horse power will elevate the water in direct proportion. A 10 ft. mill will develop one-half of one horse power; a 12 ft. mill three-fourths horse power; a 14 ft. mill two horse power, and each additional two ft. in diameter of mill develops practically an additional horse power up to a 30 ft. mill, which develops 8 horse power. The cost of the mills ranges from $40 for the smallest size to $400 for the largest.

In response to an inquiry as to the estimated number of days a windmill will run during the year, the company replies as follows: "It depends on locality. Here in Illinois total output one-third or eight hours per day. Kansas and Nebraska will average double this amount." I think the estimated average for Kansas and Nebraska, as compared with Illinois, will be accepted without question.

I further ascertained from the pump company that a 5 in. pump geared to run forty-eight 8 in. strokes per second will discharge 1,860 gallons of water per hour; a 6 in. pump geared in the same way will discharge 2,760 gallons per hour, and an 8 in. pump will discharge 4,860 gallons per hour.

THE DUTY OF WATER.

From the printed report of the Colorado State Agricultural College, at Fort Collins, Col., I learned that the duty of water, as determined by actual measurement is one cubic ft. per second running continuously for sixty to sixty-five acres of ground. This during the month of June, when the greatest amount of water is needed for irrigation. During the entire irrigation season one cubic ft. per second, if reservoired, is sufficient for 175 to 300 acres. The same report shows that by actual measurement the amount of water required for various crops ranges from 1·67 ft. to 2·53 ft. in depth. That is, if the entire amount of water necessary for the perfect irrigation of the land were applied to the land at one time, it would be necessary to cover the ground to the depth named, according to the crop to be irrigated. The report shows also that this measured depth includes the measured rainfall during the same season. For the purpose of estimates given in this paper, I will assume that the average depth required for crops is two feet.

WHAT A WINDMILL WILL DO.

From the statements made by the pump company as to the capacity of a pump, I learn that a 5 in. pump will discharge 1,860 gallons of water per hour. This is 31 gallons per minute or five-tenths gallons per second, and is equal to 0·06⅔ cubic ft. per second. On the Colorado basis, as before given, a stream running 0·06⅔ cubic ft. per second would irrigate about six acres of land; but the pump is only estimated to run about

one-third of the time, consequently one-third of the water would be secured and about two acres could be irrigated direct from the pump.

I have a large number of reports from farmers who apparently put in their windmills originally for the sole purpose of securing water for stock, but have since been successfully irrigating orchards, garden patches, etc., from the surplus water without making any attempt to reservoir it. These reports show that such surplus water is sufficient to irrigate from one to three acres of land.

Now, suppose a farmer expends a few dollars in constructing a reservoir 100 ft. square by four ft. deep, what would be the result? Such a reservoir will contain 40,000 cubic ft. or about 300,000 gallons of water. A 5 in. pump discharging 1,860 gallons of water per hour will, in one-third of a day, or eight hours, discharge 14,880 gallons. In twenty days of eight hours each (this is assuming that the windmill runs one-third of the time) 297,600 gallons of water will be secured, practically filling our 300,000 gallon reservoir. During the six months from April to September inclusive, there are nine periods of twenty days each; therefore, the reservoir can be emptied and filled nine times during the six months, resulting in an aggregate of 2,700,000 gallons of water for irrigation purposes, equal to 360,000 cubic ft.

The report of the Kansas State Board of Agriculture for last year shows that at Wallace, Kan., during the six months from April to September, the rainfall aggregated over fifteen in. We have before found that an average of two ft. in depth, including the rainfall, is required for practical irrigation; or in other words, two cubic ft. of water per square ft. of land. An acre of land contains 43,560 square ft.; therefore, to irrigate one acre of land requires 87,120 cubic ft. of water; of this $\frac{5}{12}$ or $\frac{5}{8}$ may be estimated as being the rainfall, leaving $\frac{3}{8}$ to be supplied from the reservoir. Therefore, to irrigate one acre of land during the season requires 32,670 cubic ft. of water; but our pump and reservoir will supply during the season 360,000 cubic ft., or water enough to irrigate about eleven acres.

Now, we have seen what in theory ought to be accomplished with a pump and reservoir of the capacity named; let us see what our farmer's reports show as actually being accomplished. John Simon, of Garden City, Kan., reports a windmill pumping a 5 in. stream of water into a reservoir 100 ft. square by 4 ft. deep, raising the water 12 to 15 ft. and irrigating 10 to 15 acres; the entire cost of his plant was $140, with practically no outlay for operating expenses. J. F. Monson, of Julesburg, Col., reports that he is irrigating 8 to 10 acres with two windmills raising a 3 in. stream of water 20 ft. into a reservoir 80 ft. in diameter and 4½ ft. deep. The cost of his plant was $225. J. L. Diesem, of Garden City, Kan., is irrigating 15 acres from a well 13 ft. deep, by means of a pump throwing 6,000 gallons per hour into a reservoir 140 ft. by 153 ft. and 4½ ft. deep. His plant cost $350. Examples of these results might be multiplied indefinitely; but enough have been given to show that theory and practice bear one another out, and that, at a comparatively moderate cost, it is eminently practicable to irrigate 10 to 15 acres of land by means of a windmill pump.

### DEPTH OF WELLS.

Another important question to be considered in this connection is the depth from which water can be successfully pumped by windmills for irrigation. Theoretically, a 5 in. column of water can be raised 100 ft. for each horse power developed by the windmill. The pump company states that the practical limit of raising water is about 200 or 250 ft. Among the reports which I have received from the farmers I have a number of instances where the water is being pumped from considerable depths. Among them J. C. Houser, of Grainfield, Kan., is pumping from a well 56 ft. deep. S. K. Wine, of Menlo, Kan., is pumping from a well 130 ft. deep. S. T. Percell, of Grainfield, Kan., is pumping from a well 140 ft. deep. Four wells at Weskan, Kan., are respectively 135 ft., 153 ft., 160 ft. and 140 ft. in depth. This shows that it is practicable to raise the water from a considerable depth below the surface of the ground.

### INDEPENDENCE ON FEW ACRES.

It is my opinion that the future irrigation of the plains country is to be largely carried on by means of windmill pumps. Each farmer can, independent of his neighbors or of any irrigation company, and at a cost not exceeding $250, irrigate from 10 to 15 acres of his quarter section, and 10 to 15 acres properly irrigated and carefully cultivated is as much as any man ought to undertake to cultivate under irrigation. On this irrigated ground he can raise those crops which will bring in the best financial returns, and can thereby insure himself and his family sufficient income to more than support them independent of the fluctuations of the natural rainfall. On the remaining portion of his 160 acres he can raise by dry farming the same crops in character and amount as he is now getting, and two years out of three he is bound to get magnificent crops from the non-irrigated land.

### EFFECT UPON CLIMATE.

I am further convinced that if ten acres out of each quarter section of the plains country were irrigated the resultant evaporation from the necessary reservoirs and from the irrigated land would so disturb the existing climatic conditions that the long droughts which are now liable to be experienced would be permanently broken up, and that the average annual rainfall, instead of coming at infrequent periods and in heavy driving storms, always causing more or less damage, would be obtained at frequent intervals and in the shape of gentle rains which would do the greatest amount of good. The result would be that from the non-irrigated land would be obtained each and every year fully as good crops as were obtained in western Kansas and Nebraska in 1891 and 1892.—*Irrigation Age.*

[From the Kansas City Times.]

## VISITING A CHINESE PATIENT.

The appended letter was written to a relative in Kansas City by a young lady, an M. D., who was sent by the Presbyterian Board of Foreign Missions, of New York, to take charge of a hospital at Chin Nan Foo, China. She writes of her reception by one of the dignitaries there:

Chin Nan Foo, Oct. 20.

Dear Donas: I have something very interesting to tell you this time. The great high official of the province sent a message with a present for the foreign doctor and a request, or rather an invitation, to come and see his Taitai, *i. e.*, his wife, who was sick with a skin disease. After we had accepted the invitation and the present the official runner or messenger returned to the official with the word that the present was accepted. Then the messenger returned to ask the foreign doctor when it would be convenient for her to use the chairs and servants the official would send. The messenger returned to the official with the message when the doctor would arrive.

As I could not talk Chinese yet, Mrs. Neal had to go with me, and so she dressed herself up in perfect Chinese style from head to foot, wearing the most beautiful silk garments and a gorgeous pair of shoes made for unbound Chinese feet. I borrowed some elegant clothes of one of the missionaries, and we two made-up Chinese women, escorted by our female servant, who likewise was finely dressed, got into the sedan chairs the official had sent. And this is the way the procession went: Ahead walked two official runners, then Mrs. Neal's chair, carried by two men (on their shoulders); on one side of her chair marched a man servant. Then came my chair, carried by two men, and at my side a man servant; then behind me our woman servant on a wheelbarrow.

We went through street after street until we came to an immense open courtyard. Entering this, we passed through a high gate, which was swung open by the gatekeepers at our approach; then we were in another court, which was lined on either side by houses in which the official servants lived. Passing on we entered a second gate, which took us into the second court, and so on until we had passed through eight gates and courts. Each gate swung open in this ceremonious style, and each court containing a number of servants' houses opening into it.

When we finally reached the fourth court there appeared several servants to assist us out of the chairs and up the stairs. Then passing over the threshold (which is a foot high and the most awkward thing to get over you ever saw), we found ourselves face to face with the Taitai in a large hall. At the Taitai's side stood a young woman, daughter of one of the official's wives. Behind them stood a train of about twelve servant women. The Taitai folded her hands and bowed, and Mrs. Neal did the same, shaking her folded hands the same number of times the Taitai did, and bowing just as low. Then I did the same.

Then the young woman went through the same performance, and I was introduced as U. Difer, and the bowing was repeated. Then we followed the two ladies into the adjoining room, and the Taitai said she did not know whether to give the high seat of honor on her left to me or Mrs. Neal, but Mrs. Neal insisted that I should have it; so I sat down on the left hand side of the table, and across the room was a similar table, on either side of which sat the two next women in rank. Mrs. Neal sat to my left and the servants stood around, filling the room. Tea was served immediately; then all kinds of fruits, peaches, pears, etc., and, by the way, these were cut crosswise, the fruit in very thin slices, and dealt out by chop sticks of ivory. The young lady served the food. Everything is prepared ready to eat on a Chinese table. They think our way of pulling at food with knives and forks is very funny. Then various cakes and drinks, and, strange to say, these little knicknacks we have at home, and the letters H. P. printed on each was an enigma to the Taitai, and she asked us what it meant. Mrs. Neal pronounced the letters and said they were the initials of the manufacturer. They thought it was very queer. The last course was dumplings stuffed with garlic; this we refused politely.

The Chinese always begin at the wrong end of the menu, according to our thinking; and certainly their poor digestion shows the indiscretion of calling on the stomach to digest sweetmeats and nuts first and soup last. Mrs. Neal and the Taitai carried on a lively conversation, which consisted largely of personal remarks and one insisting on the other to eat. It is impolite to touch anything until a lot of red tape has been been gone through four times.

Mrs. Neal said I would examine her skin if it was convenient, but every time the Taitai would say, "Oh, no, no hurry; rest and eat longer." She could not get over the fact that I couldn't talk Chinese; it seemed beyond her comprehension that I could not say what she could say. I used a few phrases I had picked up to the best of my advantage, but the rest of the time I felt very awkward. There is nothing can equal the awkwardness one feels in being among people whose language you do not understand. It is just distracting; your mouth fills with words, but your tongue is paralyzed.

Well, finally we got to the professional part of my call and the Taitai (that is pronounced like ti ti, with a long sound of i) took a seat near the window and I examined her face; then she threw up her sleeve and bared her arm, and I took a Chinese arm in my hand for the first time. As I did this she remarked that our skin was so much finer and whiter than hers. As I wished to see her chest she escorted us into an adjoining room and undid her garments. After asking several questions I said I would send some medicine, for I was satisfied with my diagnosis. After resting a little longer the chair bearers were called and the servants assembled; then came the bows and shaking of hands. They fold their hands and move them together up and down several times, according to the honor they wish to bestow, then bow lowly; men touch the ground to show much honor. I have had many of them give one sweep of the body and touch the ground before me. It is very strange to one at first.

Well, we bowed ourselves out and a woman servant escorted us by the hand to our closed sedan chairs (lined with silk curtains), then the men servants stepped up and closed down the front curtains at the entrance to the chairs. Then the chairs were raised by the long poles and put on the men's shoulders and we went back in all the glory in which we came.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[From the Engineer, London.]

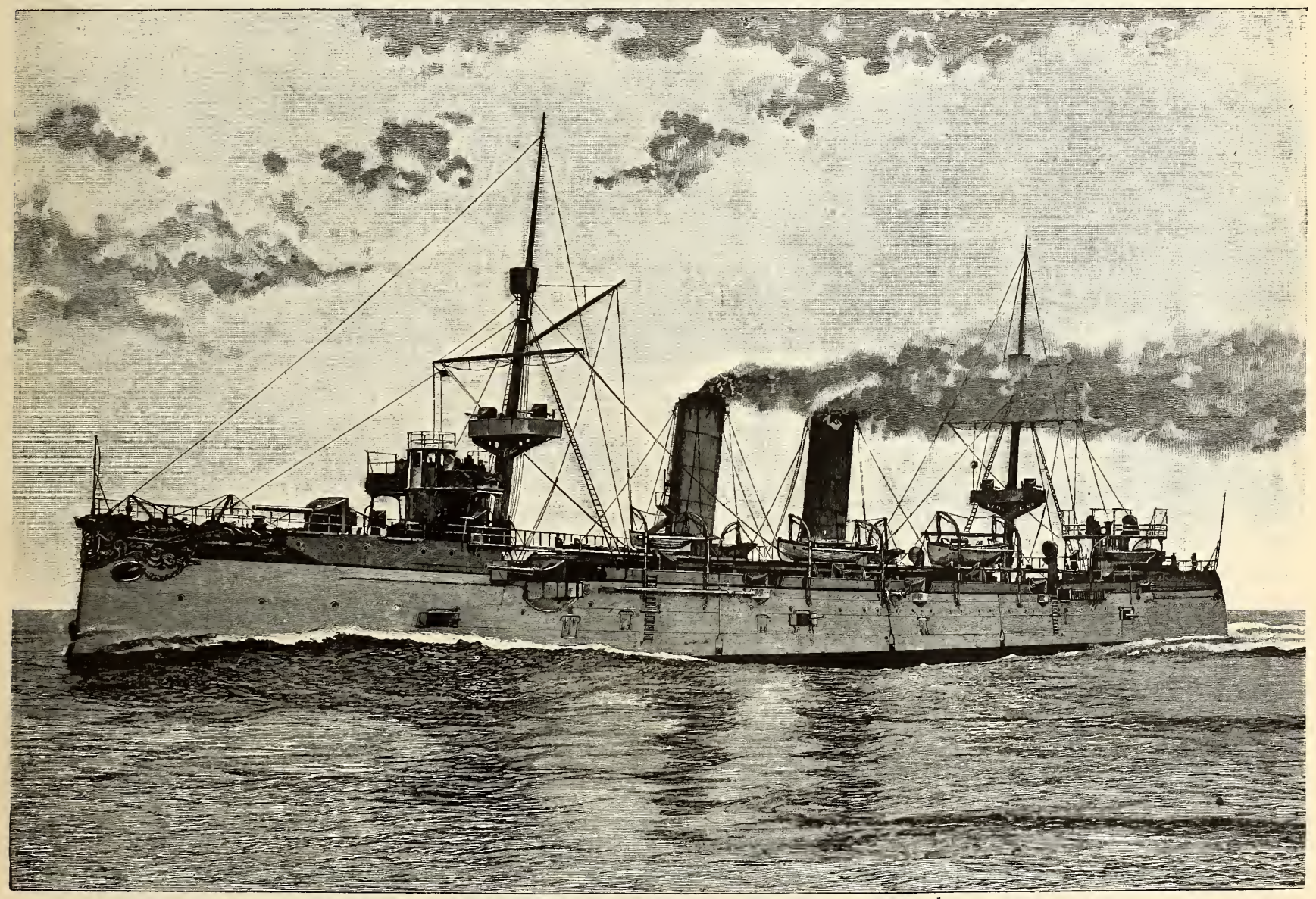
## THE JAPANESE CRUISER YOSHINO.

Our engraving illustrates the Japanese protected cruiser Yoshino running at her top speed, twenty-three knots. Our engraving has been prepared from an instantaneous photograph, for which we are indebted to Messrs. Sir W. Armstrong, Mitchell & Co., of Elswick. She is the fastest sea-going vessel in the world—faster a good deal than anything in the United States navy. Within the last two weeks she has left this country for Japan, and the reports which have been received leave no room to doubt that she is an exceedingly good sea boat as well as a powerful war ship. It is to be regretted that she belongs to a foreign government instead of to the British navy.

The Yoshino is the same class of vessel as the 9 de Julio and 25 de Mayo, constructed by the same firm for the Argentine government, but exceeds either of them in size and speed, and is, moreover, provided with a double bottom, which they have not. The results of the speed trials carried out last July off the mouth of the Tyne far exceed any yet obtained from a sea-going vessel, and prove her to be the fastest cruiser now afloat, a fact having this significance, that there does not exist anything in the form of a ship that could escape from her if pursued. The Yoshino is 350 ft. long, 46½ ft. broad, and her displacement at load draught is about 4,000 tons.

During the natural draught trials the ship attained a mean speed of 21·6 knots, with forced draught 23·031 knots, or 26·51 miles per hour. At the turning trials it was shown that the ship could turn through 360 deg. in three minutes and eight seconds; the diameter of the circle measuring 375 yards. This was considered a remarkably small circle for a vessel of the length of the Yoshino. The helm could be put from hard-a-port to hard-a-starboard in thirteen seconds, and the engines could be reversed from full speed ahead to full speed astern in a few seconds. The vessel thus possesses in a very high degree the handiness and maneuvering power which are so essential to a cruiser of this class.

The armament of the vessel consists of four 6 in., eight 4·7 in., and twenty-two 3 pounder quick-firing guns, and five torpedo tubes. One 6 in. gun is placed on the forecastle and one on the poop, each gun being capable of firing through an arc of 270 deg., or all round the bows to 45 deg. abaft the beam on either side for the forward gun, and round the stern to the same angle before the beam on both sides for the after gun. The other two 6 in. guns are carried in sponsons at the level of the upper deck, one in each bow, and have a range of fire from 3 deg. across the bow to 60 deg. abaft the beam. The eight 4·7 in. quick-firing guns are carried in sponsons at the level of the upper deck, the aftermost pair being close to the poop, and firing from 3 deg. across the stern to 60 deg. before the beam, and the other six—three on each side—have each a range of 120 deg. The twenty-two 3 pounder quick-firing guns are disposed as follows: Two at the after end of the forecastle—one on each side—so as to get a training arc of about 80 deg. abaft the beam, and two similarly placed on the poop; four are placed in the military tops, two in each; eight on the upper deck bulwarks, and the remainder between decks, thus obtaining a complete command of every possible direction of approach to the ship. One of the torpedo tubes is in the stem for right-ahead fire, the other four are training tubes, and fire on the broadside, two being placed in a chamber forward on the main deck, immediately before the machinery compartments, and the other two in a similar chamber aft of those compartments. Her machinery—as was to be expected—coming from Messrs. Humphrys, Tennant & Co., worked most satisfactorily throughout the whole of the trials, and the Japanese government may be congratulated on the possession of one of the finest, swiftest, and most powerful war ships of her class afloat.



THE JAPANESE PROTECTED CRUISER YOSHINO.

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A French paper publishes some interesting statistics as to the number of foreigners in France. It appears that there are 465,860 Belgians, 286,042 Italians, 83,000 Germans, 11,900 Austrians, 14,357 Russians, 39,687 English, 12,000 Americans, and 80,000 Spanish and Portuguese.

## THE ERA OF NICKEL-STEEL.*

By W. L. Austin, Ph.D.

Attention had long been directed to the unusual properties displayed by meteoric iron, both in regard to its extraordinary toughness as well in some instances to its non-corrodibility. Again and again during the present century investigators appear to have returned to this subject in examining the physical qualities of these celestial visitors and by endeavoring to produce artificially similar alloys. Meteoric iron is never pure, but is invariably associated with nickel and other elements and the desirable qualities attributed to it are ascribed to this fact. It became clear at an early date that iron alloyed with nickel differed materially from the pure metal, but certain obstacles were encountered in bringing these metals together, and even when this was effected the results were far from corroborating each other. Faraday experimented in this direction by melting horseshoe nails and pure nickel together in various proportions, reaching finally only contradictory results. Berthier also made some alloys of the two metals, producing a mixture corresponding to that of a meteoric iron found near Bogota. In 1861, Longmaid patented (British patent No. 1863, A. D. 1861) some alloys of iron and nickel, but used only very small amounts of the latter metal. Liebig examined the same subject in 1832. Mr. Fairbairn, in 1858, recorded the results of some experiments on alloys similar in composition to meteoric iron, and Bonssingault as well investigated the subject in connection with researches on metallic meteorites, which, in fact, seem to have been the incentive that urged on all early investigators of these alloys.

But all efforts to manufacture a commercially valuable alloy of iron and nickel were in vain until a few years ago, the trouble being that the tremendous influence of minute quantities of other accompanying metals and metalloids was not understood nor suspected. It is strange that the effect of impurities on the

* Extracts from paper read before the Colorado Scientific Society, December 4, 1893.

alloy should have been unappreciated for so long a time.

Kunzel, in his report on the Vienna Exposition, speaking of the experiments made in 1860 at the Liege cannon foundry, in which it was aimed to improve the quality of ordnance metal by the addition of a little nickel, says the result was negative, and declares he cannot understand what qualities of the iron (roheisen) or nickel warranted the undertaking. Even Ledebur himself has predicted that the new nickel-steel alloys belong to that class of inventions which crop up at intervals, finally to be buried in oblivion because of their impracticability.

Probably the first appearance of nickel-iron alloys in the United States was when Philip Thurber, of Detroit, at the New York Exposition in 1853, exhibited some products of the iron furnace at Marquette, Mich. This iron was made from a nickeliferous limonite and possessed some remarkable qualities, but it was not until 1888, after experiments had been made first in France with crucible nickel-steel alloys, and subsequently in England with similar mixtures produced in the open hearth, that the subject was brought to general notice.

In May, 1889, Mr. James Riley, at the request of the Iron and Steel Institute of Great Britain, read a paper at their meeting in Glasgow, in which he set forth the results of the experiments he had been making with nickel-steel. Riley had been over in France, at the invitation of Marbeau, for the purpose of looking into the claims made for certain crucible nickel-steels by that engineer, and having satisfied himself as to their genuineness he returned to his works in Scotland and began experimenting with similar material, using an open-hearth furnace in the place of the crucibles employed in France. The results obtained by Riley are given very fully in the proceedings of the Iron and Steel Institute. Notable among them was one nickel-steel alloy containing 4·7 per cent. nickel, which showed an elastic limit of 28 T. per square inch and a breaking strain of 40 T. per square inch, whereas similar steel, without the nickel, showed only 16 T. and 30 T. respectively. The elongation and contraction of area of this steel were, moreover, not materially impaired.

In August, 1890, the papers stated that the United States Naval Board was about to test "a newly invented nickel-steel plate" recently purchased by the Chief of the Bureau of Ordnance from the Creusot Works. On September 18 and 22 this plate was tested at Annapolis, Maryland, together with other representative armor plates submitted for trial, to ascertain which style of protective armor was the best for use on the new United States men-of-war then building. At these competitive armor trials the victory rested with the French nickel-plate steel, as against another carbon-steel French plate, and a compound one of English make. On September 26, 1890, a bill was introduced and immediately passed by the House of Representatives appropriating $1,000,000 to enable the Secretary of the Navy to purchase nickel ore and nickel mattes for armor manufacture. It appeared to outsiders as though the authorities were acting with undue haste in the matter, and immediately stories began to circulate detrimental to the new material, suggesting the possibility of a "job" lying at the bottom of the hasty action on the part of Congress. It was stated that the new steel became exceedingly brittle when subjected to great cold; that its magnetic properties were such that ships' compasses, under certain conditions, could become totally deranged; in fact, that the new product was very unreliable and uncertain in its behavior. It appeared as though experience with alloys of iron and nickel on the part of experts had been for too long a period of a doubtful nature to admit of an opposite opinion being hurriedly reached.

Mr. Tracy, however, who was at that time Secretary of the Navy, decided to have very careful tests made of this armor before adopting any kind in the new navy, and proposed to employ for such test plates that were to be made of American material by American mills. As a result of this decision, orders were given to the Bethlehem Iron Company and to Carnegie, of Pittsburg, to prepare such plates, the government furnishing the necessary nickel for the work.

Shortly afterward Mr. W. L. Abbott, of Carnegie, Phipps & Co., in reporting to Mr. Tracy the progress in the manufacture of nickel-steel plates at the Homestead Works, near Pittsburg, showed samples taken from some of the material out of which the trial plates were being manufactured, and which had been rolled down to three-fourths inch for experimental tests. These gave an ultimate tensile strength of 100,000 to 102,000 pounds per square inch, with an elastic limit of 59,000 to 60,000 pounds. The elongation was 15½ per cent., with reduction of area of 29½ and 26½ per cent. respectively at fracture.

The toughness of nickel-steel is very great. During a visit which the writer made to the Bethlehem Works last spring, a large field was observed which was covered with blocks of nickel-steel that had been cut off during the process of manufacturing the armor plates. Many of these ingots weighed several tons. They had been set out in the open field adjoining the works, because it was said that no profitable method of breaking them up into sizes suitable for returning to the furnaces had yet been devised. Attempts had been made to blast them with dynamite, but the explosive shot out of the holes as from a cannon, doing little execution on the blocks. Another illustration of the toughness of the metal is given in the late experiments by the German government, where shells were exploded in cannon—the one of ordinary gun steel, the other of nickel-steel. The former was badly damaged, whereas the latter was only enlarged.

One by one the objections raised against nickel-steel have been removed. The effect of cold weather on the plates was experimentally demonstrated to be of no importance, and in April, 1891, the first nickel-steel plates of American manufacture began to arrive at the Washington Navy Yard for testing purposes. Plates of all descriptions, with and without nickel, were exhaustively experimented with. High and low carbon steels were shot at; plates just as they were rolled or forged, and others which had been surface hardened (Harveyized), were again and again subjected to the fire of the most formidable modern ordnance made, rifles as high as 12 inch caliber being used. These tests extended all through the summer, fall and winter of 1891 and 1892, and are still in progress, a plate being taken for testing purposes from each lot of material delivered by the works. The results have demonstrated beyond all doubts the superiority of nickel-steel for armor purposes. The tough, tenacious material flows under the impact of the shot, and in the case of the Harveyized plates, the extreme hardness of the exterior surface, re-enforced by the tough, untreated steel behind, shatters the forged steel Holtzer projectiles, which have hitherto proved irresistible.

## DAHL'S SULPHATE CELLULOSE PROCESS.*

Experimental trials have been made with almost every known alkaline fluid likely to be suitable, as regards cost, for removing the incrusting materials from plant fibers. Ammonia, caustic and carbonate of soda and sodium sulphide or the corresponding salts of potassium have all been tried, yielding in some cases very indifferent results. Ammonia solutions, for example, are too inactive and are quite unsuitable. For this and other considerations it cannot be successfully used as a solvent. Like solutions of caustic potash, it is very expensive, although the latter body acts perfectly. A comparison of the relative costs of soda, potash and ammonia will not be out of place, for by this the position of caustic soda and of other alkaline soda products in the manufacture of paper pulp will be more clearly understood.

At the present time the relative costs of ammonia, soda, and potash are about as follows:

| | |
|---|---|
| Ammonia $NH_3$ | £55 per ton. |
| Potash $K_2O$ | 50 " |
| Soda $Na_2O$ | 14 " |

It is obvious from these figures that unless the quantity of potash and ammonia used for pulping is very much less than that of soda (which, in truth, is not the case), any process based upon the use of these reagents is not likely to live as a commercial manufacture.

The two alkaline soda products which have been universally adopted are caustic soda and sulphide of sodium. It is to the application of the latter that we wish to direct the attention of our paper-making readers. This reagent has been almost exclusively associated with the name of the late Mr. C. F. Dahl, an engineer of Danzig, who obtained a patent in 1884 in many European countries for a method of preparing paper pulp from fibrous plants by digesting them in aqueous solutions of sodium sulphide. During the recovery of the soda from the spent alkaline lyes, he added a proportion of sulphate of soda or salt cake to the calcining ash, which was converted into sulphide of sodium by the reduction action of the organic matter. The residuum was then dissolved in water, and the liquor causticized with the lime and again used for boiling. It appears, however, that the Manchester Paper Co., New York, boiled straw with sulphide of sodium liquors long before Dahl took out his patent in 1884. Wood and straw pulp are both made in large quantities by this process in Germany, Austria and Scandinavia at the present time.

### THE PROCESS.

The chopped wood, straw, esparto, etc., is subjected to the action of a lye containing four different combinations of soda, viz., sulphate, carbonate, hydrate and sulphide, in large wrought iron boilers. The digesting process is carried out under pressure, and it is said that 100 parts of moderately dry pine wood require about twenty parts of the above mixture of salts in solution; while straw, esparto, and similar raw stock require only 10 or 12 parts.

Spruce and other pine woods require a pressure of from 5 to 10 atmospheres (75 to 150 lb. per square inch above the atmosphere), and the strength of specific gravity of the alkaline lye varies from 6° to 14° Baume. The time required to complete the digesting varies from 4 to 30 hours. On the other hand, esparto, straw, etc., are boiled at a pressure of 2 to 4 atmospheres in a solution of 5° to 8° Baume for 3 to 8 hours, as the nature of the plant may require. During the boiling process, the incrusting materials surrounding the fibers of the plant are dissolved, while the cellulose is left behind.

When the boiling is finished the brown lye is run off from the pulp digesters and evaporated, the residue being finally calcined, then withdrawn and dissolved in water and causticized. The cellulose remaining within the boiler is removed and placed in washing vats, where it is washed with warm water to get rid of the soda. It is then broken up into pulp in a breaking engine in the usual way and bleached with bleach liquor.

The color of the unbleached pulp is grayish yellow, but it may be bleached to a high degree of whiteness or left of a slightly yellowish tint, according to the amount of bleach liquor added.

### PREPARATION OF THE LYE.

Dahl recommends that sulphate of soda be used for the preparation of the sodium sulphide liquor in the following manner: The salt cake is first dissolved in water, and then boiled with 20 or 30 per cent. of its weight of well burnt lime. The lye prepared in this way can be used for boiling the plants, but some of the soda residue recovered from the black lye is added to it to bring it up to the right composition.

The black lye is thickened to the consistency of tar by evaporation in an evaporating oven, strongly calcined, and after the gases evolved during the decomposition of the organic matter have ceased to come off and the mass is charred, the residue is withdrawn, dissolved in water, and the resulting solution used for preparing fresh lye.

For preparing the pure salt without mixing it with carbonaceous matter, the thickened lye is withdrawn from the furnace and burned by itself in a smelting furnace at a dull red heat. The melted mass assumes a brownish red color on cooling, is easily soluble in water and possesses nearly the following composition:

| | |
|---|---|
| Sulphate of soda | 16 per cent. |
| Carbonate of soda | 50 " |
| Caustic soda | 20 " |
| Sodium sulphide | 10 " |
| Foreign substances | 4 " |
| | 100 |

The composition of this recovered product varies a good deal in accordance with the nature of the fibrous materials which are being digested and with the care with which the furnacing has been carried out. These, however, do not interfere much with the solvent power of the liquor which is afterward made from it.

This recovered salt is now dissolved as soon as possible after it is withdrawn from the furnace, in order to avoid oxidation of the sulphide of sodium, which, as every chemist knows, is rapidly oxidized when exposed to the air. During the boiling and recovering processes from 10 to 15 per cent. of the salt is lost. Under normal conditions of work this loss is replaced by an equivalent quantity of sulphate of soda or salt cake. That is to say the correct lye for boiling by this process is made from a mixture of 85 per cent. to 90 per cent. of recovered salt of the above composition, 10 to 15 per cent. of sulphate of soda dissolved in water and boiled with 20 or 30 per cent. of burnt lime. According to Dahl, the proportions of recovered salt, salt cake, and lime used for preparing fresh lye depends upon the percentage recovered. Thus the following figures are the proportions given by him:

| Percentage loss of Salt. | Recovered Salt. | Sulphate of Soda. | Burnt Lime. |
|---|---|---|---|
| 10 per cent. | 90 parts | 10 parts | 20 parts |
| 15 " | 85 " | 15 " | 23 " |
| 20 " | 80 " | 20 " | 25 " |
| 25 " | 75 " | 25 " | 28 " |
| 30 " | 70 " | 30 " | 32 " |

It is not advisable to add more than 30 per cent. of sulphate of soda to the recovered salt, because the liquors will then be very inactive and fail to properly reduce the fibrous plant to pulp.

The proportions of salts contained in the liquor are on an average as follows:

| | |
|---|---|
| Sulphate of soda | 37 per cent. |
| Carbonate of soda | 8 " |
| Caustic soda | 24 " |
| Sulphide of sodium | 28 " |
| Foreign salts (inactive) | 3 " |

Unless great care be exercised in the recovery, etc., of the soda, the composition of the liquor as above stated changes a good deal. The general aim of the manufacturer should be to obtain as large a decomposition of the sulphate of soda into sulphide of sodium as is possible.

It is said that the soda made by Leblanc's method is better than ammonia soda for Dahl's process, because it contains sulphide of sodium. Sulphate of soda or salt cake is also much cheaper than soda ($Na_2O$), and as the sulphide of sodium which it yields is already "caustic," if the term can be used in a perverted sense, less lime is required to prepare the liquors for the digesters. On the other hand, more ash or soda residue is recovered per ton of pulp made than in the ordinary soda pulp process, which means fractionally more expense in this department.

The knowledge of the reaction going on within the pulp boiler is very limited, but experience certainly shows that the fiber is stronger, and is consequently of more value. Dahl also claims to get a higher yield of pulp, about 10 per cent. increase, in fact, over the caustic soda method, when working his process.

In a German factory where this system was continuously worked for some years, seven parts of recovered soda residue and two parts of lime were used for causticizing. On 3,000 parts of good recovered residue, 700 to 800 parts of lime were used in Dahl's system, while in the soda process 1,200 to 1,300 parts of lime are required. A properly managed sulphate cellulose factory should not use more than 30 parts of burnt lime per 100 parts of pulp; and a soda cellulose factory not more than 50 parts of lime for the same weight of product.

* From *The Chemical Trade Journal.*

## ANTICHLORS.*

When paper pulp is bleached with gaseous chlorine, or with solutions of hypochlorites, the bleaching agent is supposed to penetrate into the pores of the fibers, and to be removed with great difficulty in the ordinary process of washing. Hence there has arisen the necessity of destroying the remaining chlorine or hypochlorite by the aid of a chemical reagent. The reagents thus employed are called "antichlors." They attack the chlorine, transforming it and themselves into comparatively harmless bodies, which are either washed from the pulp before sizing or are left remaining in it, and for the most part pass away with the water from the machine.

From a chemical point of view all antichlors are reducing or deoxidizing agents, with but one exception, namely, ammonia. Those in common use are mainly formed by the union of sulphurous or other oxy-acid of sulphur with soda, and, in fact, comprise the following series of salts:

| | |
|---|---|
| Hyposulphite of soda | $Na_2S_2O_3 + 9Aq.$ |
| Sulphite of soda | $Na_2SO_3 + 6Aq.$ |
| Bisulphite of soda | $NaHSO_3$ |

The two former of these are well defined crystalline salts, and are sold as such; but the last is a liquid and sold as a strong aqueous solution in casks.

As above stated, there is a fourth antichlor, namely, ammonia, which is used in the state of hydrate or as liquor ammonia, and is the only alkali that is found to be applicable in virtue of its well-known reaction with chlorine, thus: $4NH_3 + 3Cl = 3NH_4Cl + N$. The products of this reaction, gaseous nitrogen and sal-ammoniac, are perfectly harmless, both as regards their action on the pulp or on the machinery, and, therefore, ammonia is considered to be the best antichlor known. It possesses, however, a disagreeable, stifling smell, is rather offensive to use, is much more costly than any of the antichlors above enumerated, and hence its application is limited. According to Lunge and Schoch, it is necessary to add a somewhat large excess to the pulp and to allow it to remain in contact for a considerable time before it acts effectually, both of which conditions are against its general practical use. In the manufacture of copper plate papers, where the presence of the sulphur antichlors and the products of their decomposition are apt to act upon the engraved plate, ammonia is certainly the best and most suitable antichlor.

* From *The Chemical Trade Journal.*

Hyposulphite of soda, a crystalline salt extensively manufactured on the Tyne, by the oxidation of soda waste, is the most universally used antichlor. Its action is similar to that of sulphite and bisulphite of soda. The chlorine decomposes the water in the presence of this salt, forming hydrochloric acid, and liberating oxygen, which oxidizes the hyposulphurous acid to sulphuric acid, which in its turn forms acid sulphate of soda. Another reaction of greater importance to the paper maker can take place instead of the above, yielding bodies that must be considered more dangerous than acid sulphate of soda.

The hydrochloric acid can act upon the hyposulphite of soda and liberate free hyposulphurous acid, which, being an unstable body, splits up into free sulphur and sulphurous acid. The former of these two bodies remains in the pulp, and may give rise to disagreeable results. It is also liable to slow oxidation to sulphuric acid, which will locally destroy the fiber. It is generally recognized among paper makers that the excessive use of this antichlor tends to destroy the wire cloth of the paper machine, and there is no gainsaying this fact. Yet, hyposulphite of soda can be used without causing any damage. Care should be taken that the quantity employed is not greater than that necessary to kill the chlorine, allowing for a moderate excess, and that the pulp is washed after the chlorine has been practically destroyed. Where water is scarce, or the beating capacity of the mill is insufficient, it will undoubtedly be found that the wires will be rapidly destroyed by the free use of this antichlor. In such instances hyposulphite of soda should be used judiciously.

Both sulphite and bisulphite of soda are superior antichlors in many respects to the above one; neither of them acts so deleteriously upon the wire cloth nor upon the brass rolls of the machine. There are several kinds of those antichlors in the market, differing from one another with regard to the percentage of sulphurous acid they contain, or the amount of chlorine they will destroy. Many years ago one of the firms now embraced in the United Alkali Company, Limited, introduced to the paper trade a very pure sulphite of soda, containing a large percentage of sulphurous acid, which for cheapness and strength has not been equaled or surpassed. This product is a hydrated sulphite of soda of somewhat indefinite chemical composition, but may be said to be substantially the hydrated salt $Na_2SO_3 + 2H_2O$. Like the crystallized sulphite, which contains six equivalents of water, it is freely soluble in water, but should not be stored, nor dissolved, in wooden vessels, owing to its action on the wood. Where much antichlor is employed, and especially when acid has been used to accelerate the bleaching process, it is better to dissolve an equal weight of carbonate of soda with the sulphite. The alkali has the property of neutralizing any acids that are present in the pulp, and those that are formed during the subsequent treatment.

The finest papers are prepared from white cotton and linen rags, and require little bleach liquor to bleach them. The action of hypochlorite of lime (bleaching powder) is much less destructive upon the fiber than chlorine gas, and consequently the latter is seldom used for this class of work. This is also true of other fibers as well. The destructive action of gas bleaching is due to the formation of free hydrochloric acid, which "tenders" the fiber by transforming it into hydrocellulose.

There are some colors which are destroyed by the smallest trace of chlorine or hypochlorite, and it is imperative that the excess of bleach liquor associated with the pulp be either removed by washing or destroyed by the careful use of an antichlor. In cases of tub sizing it is especially advisable not to use an antichlor at all, but to wash the pulp with pure water till it is shown on testing to be free from chlorine by the iodide of potassium and starch test; or to add just enough bleach liquor to bring the color up to the desired degree of whiteness, so that no excess of hypochlorite will remain. The presence of chlorine in pulp for tub-sized papers is quite as bad as the presence of antichlors. It has been found by experience that the presence of either free chlorine or antichlors in papers which have been tub-sized causes the latter to undergo a change when kept for a time, and the judicious use of both is the best course that can be recommended.

## SULPHITE DIGESTER LININGS.*

IN the early days of the sulphite wood pulp manufacture, the greatest difficulty to be overcome was found to be in the construction of boilers that would effectually withstand the corrosive action of the bisulphite liquor. In the year 1866, the inventor of the "sulphite process" employed a lead lining, and today this method of protecting the iron shell is still in use. It was found at that early period that the sheet lead crumbled and cracked after working for a short time, necessitating constant and extensive repairs, with corresponding stoppages. Wherever this method of lining is employed, the frequent stoppages for repairs still exist; and it is not surprising that practical men should endeavor to shun it and try to find a proper substitute, to insure more continuous working.

Much ingenuity has, therefore, been displayed in the several schemes proposed to overcome the difficulties of this question. Some of these proposals doubtless suggested themselves to Mr. Tilghman, the original inventor of the process, in the early days of his experiments, but were not followed up by him, because of the many fears as to the future, and the expense involved in the development of what was then a very difficult manufacture.

The reason why lead is apt to crumble and crack apparently lies in the fact that the ratio of the coefficient of expansion of this metal to that of iron is as 28:12; and also in the peculiar property possessed by lead of refusing to contract to its original length when heated and cooled. That is to say, a strip elongates when repeatedly heated and cooled. To counteract this an alloy of antimony and lead was early suggested, which was found to yield properties superior to pure lead, inasmuch as first, the alloy was much harder, and second, the difference in expansibility between it and iron was not so great. The use of this alloy was nevertheless found to be faulty in many respects, and it has had to give way to another; and, also, to other linings which to-day constitute the most prominent detail in the construction of sulphite pulp digesters.

The alloy referred to is that of so-called "bronze," a mixture of copper and tin. Digesters made entirely of this material originated in America, and great expectations were based on some early results obtained with them. Good bronze, of uniform texture, if one may so speak, is, however, difficult to make, especially when the castings are large; and it was soon found that the bronze showed local wear and tear, causing parts of the digester to become weak. A deplorable accident which occurred in the United States with one of these boilers has made manufacturers regard them less favorably, and although several of them are still working in America, owing to the above and to their great original cost, their future application is not assured.

The most ingenious, and at the same time the most universally employed, lining with all its modifications was first suggested and developed by Mitscherlich in 1876. The object he had in view was to coat the interior of an iron digester with an acid-resisting substance which would not bulge or crack by heating, and which would be more durable than lead. After much patient experiment he constructed a digester, the outer shell of which was of steel plate protected inside from corrosive action by a lining of glazed bricks, tongued and grooved and set together with cement. As an additional protection, a thin sheet of lead was placed between the shell and the bricks (*C. T. J.*, 296, *p.* 42). The principle of this method is one which has been largely adopted in a series of modified applications, all more or less successful, but associated with names other than that of Mitscherlich.

Cement when "set" is fairly acid-resisting, and possesses nearly the same coefficient of expansion as iron. It therefore forms a very efficient lining; and many modified methods of employing this body as the basis of a lining have been introduced. Kellner and Partington in England, Wenzel in Austria, and a host of others too numerous to mention by name, in America, Germany, and Scandinavia, have their own peculiar methods of applying it.

Kellner and Partington's method, which is used in the well-known Barrow Pulp Works, consists in forming the lining of a mixture of cement and ground slate, thoroughly incorporated with a solution of silicate of soda in a mortar mill. This paste is applied to the cleansed boiler shell in a series of layers, the compositions of which differ from one another in regard to the quantity of silicate in the mixture; the layer nearest the shell containing proportionately the most. Small bricks or tiles are embedded in the paste, to add to its acid-resisting properties; and instead of ground slate, sand, ground glass, bricks, or hard burnt earthenware are substituted. There cannot be any possibility of doubt as to the success of this lining for sulphite pulp digesters.

Another system, closely resembling the above, has been working for many years on the Continent with equally signal success. It was introduced into an Austrian works by the late Wm. Wenzel, of Vienna, and employs porcelain tiles embedded in a mixture of cement and ground earthenware or fire bricks. The tiles are shaped to fit the curvature of the boiler, and form a smooth surface, which offers little resistance to the travel of the pulp within the boiler.

The formulæ for making the cement are not all alike, but the following is likely to answer well:

| | |
|---|---|
| Ground earthenware.. } Ground firebricks .. } | In equal proportions. |
| Sodium silicate solution 30° B..... .. ..... | 1 part to 2 of above mixture. |

The Wenzel lining has now been working uninterruptedly in Continental pulp factories for some years, which in itself is a guarantee of its efficiency.

It will be unnecessary in this cursory review of the methods of lining sulphite digesters to dwell longer on those schemes in which earthenware bricks, tiles, and cement are the component parts, for the above examples are typical of many others so closely resembling them that it is difficult to discriminate their special features, which would enable one to isolate them as individual methods. There is, however, another lining which we have not mentioned, namely, that brought out by Salamon and Brugger about three years ago.

This consists of a thick coating of sulphate of lime deposited upon the inner surface of the boiler, and is said to effectually protect the iron. It is a matter of common knowledge that water while hot holds less sulphate of lime in solution than when cold. Advantage has been taken of this by these inventors for forming their deposit upon the boiler. The digester is filled with a cold saturated solution of sulphate of lime and heated, insoluble sulphate of lime of a very dense hard character is deposited, and as the water evaporates more solution is added till the deposit has increased to the desired thickness. Digesters protected by this coating are at work in the United States and in Germany, yielding, apparently, good results.

Enamels have also been suggested for lining pulp digesters, but they do not seem to have found as much favor as cements. The following, however, is an enamel which forms the subject of an American patent:

| | Parts. |
|---|---|
| Lime | 5 |
| Fluorspar | 10 |
| Salt | 5 |
| White sand | 50 |
| Litharge | 50 |
| Boric acid | 20 |

The whole is mixed and melted together, then ground and mixed with water to the consistency of paint, and applied hot to the digester plates. A second coat is then added composed of:

| | Parts. |
|---|---|
| Calcined bones | 10 |
| Talc | 5 |
| Cryolite | 4 |

There are many advantages to be gained by the use of these linings in preference to the older lead lining. Their original cost is undoubtedly greater, but they last much longer, cost less for repairs, allow the work to proceed with greater regularity, and, what is of greater importance, more effectually protect the iron boiler. To get good results with any of them, the most scrupulous care must be exercised in their formation and in their examination while in work. A fracture, which would allow the bisulphite liquor to penetrate to the shell will cause corrosion of the plate sooner or later, and, therefore, the interior must be examined periodically. The brick or tile and sulphate of lime linings also act as non-conductors of heat. They, therefore, assist greatly in the economy of fuel and in preventing the undue dilution of the liquor within the digester.

* From *The Chemical Trade Journal.*

## TUNNELS NEAR NEW YORK CITY.

DAYLIGHT broke through the tunnel of the New York, Susquehanna and Western Railroad Company, under Weehawken Heights, for the first time lately. That does not mean, however, that the tunnel is completed, but merely that the "heading" or upper part of the tunnel has been "drifted" through from end to end, preparing the way for excavating the "bench" or lower part. The object of this tunnel is to enable the company to reach the river front without running its trains over the tracks of other roads. At present the company's passenger trains run over the Pennsylvania Railroad Company's tracks from Marion to Jersey City, and its coal and freight trains over the Delaware, Lackawanna and Western Railroad Company's tracks from West End Junction, beyond Marion, to Hoboken. In order to secure its own terminal on the Hudson River, the company, a few years ago, acquired sixty acres of land in the village of Edgewater, about two miles north from Weehawken and opposite One Hundred and Tenth Street. This land has a frontage of 1,500 feet on the river, and affords ample room for handling a large number of trains daily. Then the tunnel was projected to connect the terminal with the main line at Little Ferry Junction, ten miles from Jersey City and three miles almost due west from the terminal at Edgewater.

The tunnel is 5,072 feet long, 21 feet high to the crown of the arch and 28 feet wide, giving ample room for double tracks. The estimated total cost of the tunnel, including the three miles of double track to Little Ferry Junction, the sixty acres of land, two piers which are being built and the necessary switches and sidings at the terminal, is $1,700,000.

When the tunnel is completed only the freight and coal trains will be run through it to the river at first, but ultimately ferry slips will be constructed and passenger trains will run through it, and the passengers will be transferred to this city by boats. Ground was broken for the tunnel on August 1, 1892, and since then about 900 men have been employed in its construction, while about 150 have been engaged in building the piers, etc., on the river front. The tunnel, the three-mile spur of railroad and the terminal will be completed about June 1.

The first step in the construction of the tunnel was to sink three vertical shafts, at equidistant points, from the surface of the Palisades to the grade of the tunnel. These shafts are each ten feet long and twenty feet wide, the greatest depth being 196 feet. When the shafts had been sunk, two gangs of workmen in each began "drifting," or excavating in opposite directions, to meet the gangs which were "drifting" toward them from the other shafts. The "heading" or upper section of the tunnel is eight feet high, and was bored entirely through rock. In "drifting," steam drills are used. Six or eight holes converging to a point are drilled and charged with explosives. These holes are from six to eight feet in depth, and are charged with dynamite, giant powder and other explosives. When the blast occurs an immense wedge-shaped piece of rock is thrown outward into the part of the tunnel already excavated, removed on a temporary tramway constructed for the purpose and hoisted to the surface through the shafts by steam elevators. The blasting out of the wedge-shaped rock leaves a hole six or eight feet deep or long in the center of the tunnel, so that space is provided for receiving the fragments of rock afterward blasted from the sides, which is done in the same way, except that the holes are drilled parallel with the direction of the tunnel, which runs almost exactly east and west.

The upper part or heading having been completed, the excavation of the bench or lower part, which is thirteen feet high, is comparatively easy, as, instead of having to work laterally, the drilling and blasting are done vertically from above downward. Throughout the entire length of 5,072 feet arching was found necessary for a distance of only about 300 feet, the rock being sufficiently solid to serve as a natural arch.

The arching is of brick and cement, three feet thick, which means nine courses of brick laid on edge. The distance necessary to be arched is remarkably small, especially when compared with that of other tunnels under the Palisades. The tunnel of the West Shore Railroad Company at Weehawken is 4,200 feet long, and about 50 per cent. of it is arched, while of that of the Delaware, Lackawanna and Western Railroad Company at Hoboken, which is 4,600 feet long, about 75 per cent. is arched. The portals of the new tunnel will be handsomely faced with cut red sandstone.

While the tunnels under the Palisades are of great utility, they become insignificant when compared with many other much longer ones in this country and Europe, which are at a much greater depth. The Hoosac Tunnel, in Western Massachusetts, is four and three-quarters miles long, and its principal working shaft was 1,028 feet deep.

Early in the work of its construction the heavy timber braces which were used to support the earth and rock during the building of arches were burned, causing the loss of twenty lives and the obstruction of the tunnel for a considerable time. The St. Gothard Tunnel, in Switzerland, is over nine and a half miles long, and the Mont Cenis Tunnel, in Italy, is seven and one-quarter miles long.

### THE EAST RIVER TUNNEL.

The construction of the East River Tunnel is going on rapidly. This tunnel was projected by the East River Gas Company, of Long Island City. This company now supplies the gas used in that city. It has a gas plant at Ravenswood, L. I., opposite Seventy-first street, which it is rapidly enlarging, with a view of supplying gas not only to private consumers in this city, but also to the gas companies by whom they have hitherto been supplied. To facilitate this, a cylindrical subaqueous tunnel for its mains, composed of plates

of iron securely bolted together, was planned, and about 650 feet of it has already been completed. The tunnel will run from Ravenswood to East Seventy-first Street, passing under Blackwell's Island, near the middle of the island. It will be 2,500 feet long and ten feet in diameter. The work was begun about eighteen months ago by sinking working shafts at both ends of the line.

The shaft in this city is 147 feet deep, and that in Ravenswood 134 feet deep. Each is sixteen feet in diameter, and each has a powerful steam elevator for hoisting out the excavated material. When the level of the proposed tunnel was reached, then began the difficult and dangerous subaqueous tunneling through soft mud, 124 feet below the river's surface and 60 feet below its bed. The old style of driving a subaqueous tunnel involved the use of large quantities of heavy timbers, and was extremely unsatisfactory. In driving a top heading, steel roof plates were put in. These were ⅛ inch thick, 3 feet long and 1 foot wide, and rolled to a curve corresponding with the curvature of the tunnel. After the heading had been driven about twenty feet, a mud sill, being a heavy, yellow pine timber, twelve inches square, was introduced, and wooden braces resting on this supported the roof and sides of the tunnel, the braces radiating from the timber like spokes from the hub of a wheel. The tunnel was then excavated for about ten feet, the brick work introduced and the operation repeated.

Chief Engineer Walton I. Aimes, who is constructing the East River Tunnel, and who was engineer in charge of the construction of the Hudson Rivel Tunnel, has invented a new method of subaqueous tunneling, which he is now using in boring the East River Tunnel. This consists of a cylindrical shield made of steel plates, and is of a little larger diameter than the tunnel. Its forward end is closed by massive iron plates, but has four small iron doors, which may be opened when necessary. This shield, in which the men work, is pushed forward through the soft mud by means of twelve hydraulic jacks, each of which exerts a pressure of 5,000 pounds to the square inch, or fifty tons each, making 600 tons for all. This tremendous pressure compacts the material ahead of the shield, so that it may be readily excavated. The water is excluded and the walls of the tunnel sustained against external pressure during their construction by compressed air, and the workmen enter and leave the tunnel through air-locks.

The air pressure in the East River Tunnel is forty-eight pounds to the square inch, while that in the caissons underlying the towers of the Brooklyn Bridge and used in their construction was only forty pounds. Some difficulty is experienced in procuring workmen, as many are unable to endure this pressure. The men are paid $3 each a day, and are required to undergo a medical examination before they are employed. Only sound and robust men are accepted, as men who have heart trouble and some other maladies would inevitably be killed. Four men have thus far been killed by the air pressure in this tunnel. The best men can work only two hours at a time in the tunnel, which is lighted by electricity. Then they work two hours on the surface, and, returning to the tunnel, work two hours more, making six hours in all, which is regarded as a full day's work. The men who have lost their lives are said to have been victims of their own carelessness in coming too quickly from a high artificial pressure to the lower normal pressure, when they were seized with bleeding from the mouth, nose and ears, and quickly collapsed. The number of experienced tunnelers now employed is about fifty.

The plates composing the walls of the tunnel are of cast iron, one and one-fourth inches thick, sixteen inches wide and three feet long. Their edges are angled, or flanged, so that they may be securely bolted together, and the joints are perfectly water-tight. The flanges, when bolted together, are like the ribs of a ship and give strength to the walls. In preparing to put the plates in position the shield is pressed forward into the mud a distance of about twenty inches, and a rear projection or flange of the shield excludes the mud while the plates are being bolted together. When one course of plates has been secured the shield is again moved forward and the next course of plates is placed in position, and so on. In this manner about five feet of the tunnel are completed daily. Blackwell's Island is now only about 175 feet from the shield, and when it is reached it is expected that ten feet of the tunnel will be completed daily, as drifting through rock and earth is much easier and simpler than the work now in progress.

The strata through which the tunnel has been bored have yielded many beautiful specimens of pyrites in almost perfect crystallization. These were embedded in a black, coal-like substance, resembling peat, and indicating that a point sixty feet below the bed of the river and 124 feet below its surface was formerly high and dry and covered with vegetation. Corresponding progress is being made at the other end of the tunnel, which, it is expected, will be completed early next summer. The company has already laid about twenty-five miles of gas mains in this city, and the work is still going on.

The fact that the gas works in this city are situated in densely populated districts, and that sooner or later, for obvious reasons, those works will have to be abandoned, induced the East River Gas Company to begin building the tunnel and enlarging its works at Ravenswood, with a view of ultimately manufacturing and supplying all the gas consumed in this city. The companies by which gas is now supplied in this city are the Consolidated, Equitable, Mutual and Standard. In recent years the use of naphtha has been in a large degree substituted for coal in the manufacture of gas by the local companies, which makes its production not only disagreeable to people who live near the gas works, but also dangerous. About 1,000,000 barrels of naphtha are annually used in the manufacture of gas in this city. The enlarged works of the East River Gas Company will have a capacity for producing 50,000,000 cubic feet of gas a day, which is 10,000,000 feet in excess of the quantity now consumed in this city. President McMillan, of the East River Company, says it will not be a long time before the manufacture of gas will be prohibited in this city, but that when the company's ambitious plans shall have been carried out, the company will be able to supply all the gas required and at a reduced price, as one company with large works can manufacture much more cheaply than several companies with small works.

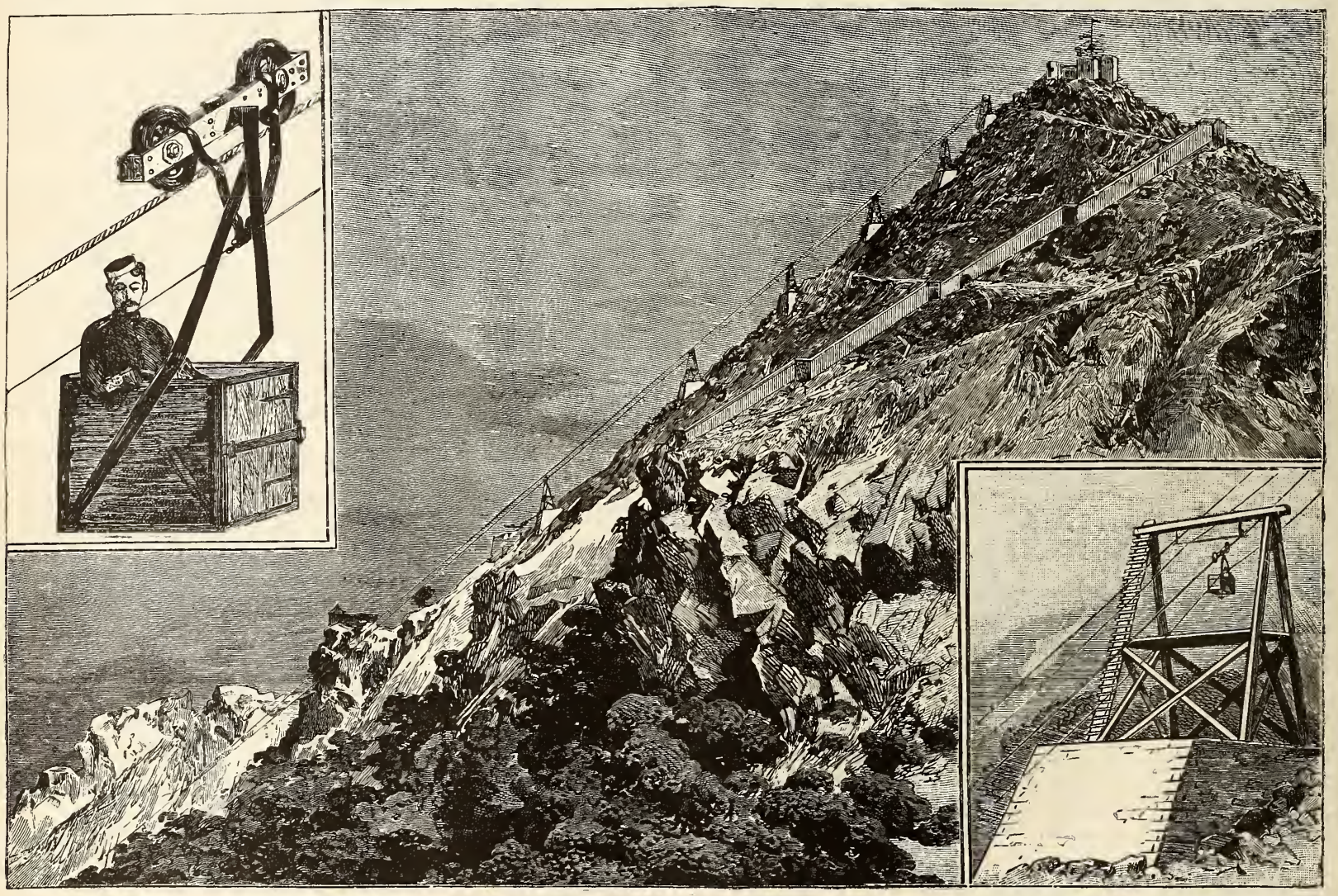
### THE HUDSON RIVER TUNNEL.

Work on the Hudson River Tunnel, to extend from Fifteenth Street, Jersey City, to Morton Street, in this city, was suspended in 1892, through lack of funds for carrying it on. The plans for the undertaking contemplated a tunnel of eighteen feet diameter, in the clear, and 5,600 feet long. At Morton Street an underground railway terminal was to be constructed, and not only passenger trains, but also freight trains of every kind, were to run through the tunnel into this city. Cold storage warehouses were to be erected above the terminal for the reception of meat, etc. The construction of the tunnel was begun by a private company in 1878. Up to 1890 there had been 2,000 feet finished, and from then until work was stopped in 1892 there were 2,000 feet more constructed, so that only 1,600 feet remains to be built. The Tunnel is composed of cast iron plates, like those of the East River Tunnel. The cost of construction was $300 a lineal foot, or a total of $1,680,000, which is only about one-tenth of the estimated cost of a suspension bridge over the Hudson River.

In 1880, when only about 100 yards of the tunnel had been completed, it was suddenly flooded by the bursting in of the water of the river, and twenty workmen were drowned. The last work done on the tunnel was paid for with English capital. A meeting was recently held in London to devise means for providing about $1,000,000 needed to complete the tunnel and terminal, but nothing was done, as the construction company has a lien on the unissued bonds. It is believed, however, that the requisite funds will soon be provided, and the tunnel and terminal completed.

The tunnels of the world are classified as railroad tunnels, which are bored through earth and stone above the level of the sea; subaqueous tunnels; canal tunnels, by means of which the courses of the canals are straightened by boring through hills or mountains; and conduit tunnels, which are used for conveying water by its own gravitation. There are in the world about 1,000 railroad tunnels, which are about 350 miles long; 12 subaqueous tunnels, 9 miles long; 90 canal tunnels, 70 miles long and 40 conduit tunnels, 85 miles long. Approximately, there are in the world 1,142 tunnels of all kinds, having a total length of 514 miles.—*N. Y. Tribune.*

A Passenger in the Car of the Aerial Railway.



One of the Trestles which Supports the Aerial Railway.

## THE AERIAL RAILWAY AT GIBRALTAR.

### THE AERIAL RAILWAY AT GIBRALTAR.

From the day when Gibraltar was captured by Admiral Rooke, in 1704, the art of the engineers has been constantly employed in strengthening the naturally powerful defenses of this mighty fortress, which at the present time is considered as "impregnable." A recent and important addition to these is the aerial railway which now connects the signal station with the south end of the town. By means of it *materiel* of all kinds—formerly conveyed in carts by a steep and tedious route—is now transferred to the summit of the rock in less than five minutes. At the north end of the Alameda is the engine house, from which two cables rise, with a stretch of three hundred yards, as far as the edge of the cliff. Above this point the convex shape of the rock necessitated their being raised to the required height from the ground by means of huge trestles. The longest wire span in Europe (unsupported between the ends) is that of a similar railway in the Pyrenees, no less than 1,200 yards in length. A powerful horizontal engine works the hawsers connected with the two

cars, pulling the one up and the other down simultaneously. Although, to those ignorant of the laws of gravity, an ascent appears to be fraught with peril, there is not the least danger of the cars overturning or the cables breaking. The latter, though capable of resisting a strain up to seventy tons, are not required to carry a load of more than one-twelfth of that weight. The peak on which the signal station stands has for centuries past served for the same purpose, as is shown by its Spanish name "El Hacho," which means a faggot saturated with pitch—the "balefire" of olden times.

Our illustration is from a sketch by H. Rose, Lieutenant Black Watch, Gibraltar.—*The Graphic, London.*

## THE CYCLE EXHIBITION AT PARIS.

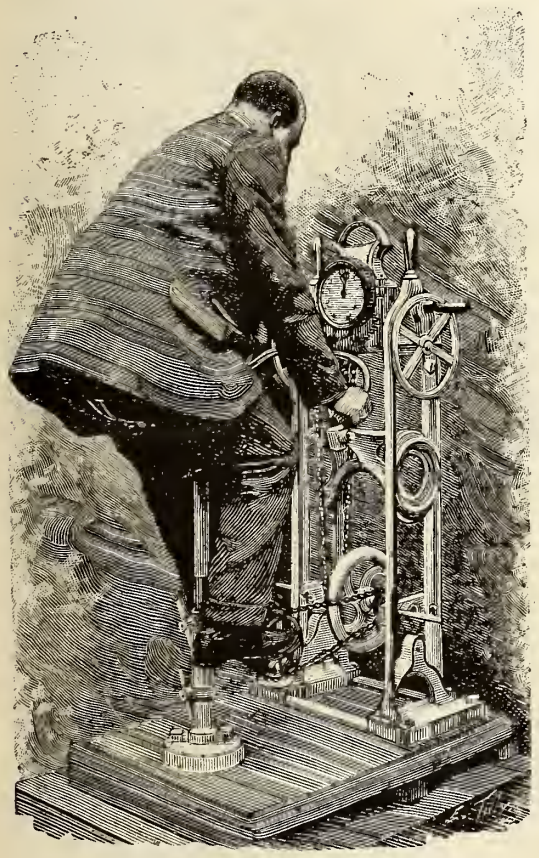
THE first cycle exhibition ever organized in France is now open. Although it cedes in no respect to those of our neighbors, the English, we must, nevertheless, state that we are, unfortunately, far behind them, since biennial exhibitions known by the name of Stanley shows and national shows have taken place regularly for the last fifteen years in England.

The *Salon du Cycle* is installed in Wagram Hall, and its legitimate success does the greatest honor to its organizers, and especially to Mr. Bivort, who was the first to conceive the idea of it and to have the courage to put it into execution.

More than two hundred exhibitors have responded to his call, and all seem to have striven with good taste and elegance to have their stands prove as attractive as possible to the visitors.

Among the rich fabrics and chatoyant velvets with fringes of gold with which the stands are draped, the bicycles and machines of varied types, enameled and brightly nickel plated, vie with each other in lightness, elegance, precision and finish.

The pneumatic tire machines are in special favor with the public, and the eager crowd listens attentive-



THE PARLOR CYCLE.

ly to the demonstrations that the manufacturers make of their various systems, which are less liable to crack and are more elastic, lighter and more easily detachable than any other!

Among so many attractions we have noticed some that constitute genuine novelties.

The Valere bicycle is, beyond a doubt, the hit of the exhibition, and its inventor offers something that is really new. He has attacked the solution of the hardest problem in cycling—the simultaneous utilization of the arms and legs for the propulsion of machines.

The innovation has raised quite a controversy in the velocipedic press. However this may be, the results obtained are too convincing to permit Mr. Valere's tentative to be treated as visionary.

We have before our eyes an indisputable document—a bulletin of the experiments made at the Department of Agriculture (*Section of Machines*) whence it results that the rendering of the apparatus under consideration is greater by half than that of our best machines.

It is, in fact, beyond doubt that the alternate use of the arms and legs can lead only to manifold advantages, in regularly and systematically developing the muscles and in better distributing the work to be furnished, thus preventing the overdriving of a single organ.

The Valere bicycle is provided in front with two large levers jointed to the frame, and which, through the intermedium of connecting rods at the lower part, help work the cranks moved by the feet. In action, while the right leg, for example, is moving forward, the left arm is effecting a motion in the opposite direction in pulling its corresponding lever. There is a simultaneous and contrary stress of the arms and legs—a motion of repulsion of the one and of traction of the other. The two forces, therefore, act fully in making use of each other mutually as a point of support.

The similitude of the motions with those of a person running is striking, and this well justifies the name of "running machine," given by the inventor.

In this bicycle the balancing and steering are effected through a system of rods and levers actuated by handles. It suffices, in running, to oblique these more or less in order to steer the apparatus. The arrangement is complicated, and that is the only weak point of the machine.

The "Valere" is essentially rapid, or "quick," according to the popular expression. The road model exhibited makes eight meters per revolution, and that, too, it appears, without occasioning any more fatigue, while ordinary bicycles cover but five meters per revolution of the pedal.

For the future. such a result may allow fantastic speeds of 60 kilometers per hour to be foreseen in races! But is this machine practical?

The steering of it, which is a somewhat delicate matter, will require some little practice; and will not the falls that are so common with bicycles be attended with serious injuries to its so complex parts? So the

THE RUNNING MACHINE.

tricycle established according to the same order of ideas is unquestionably preferable to it.

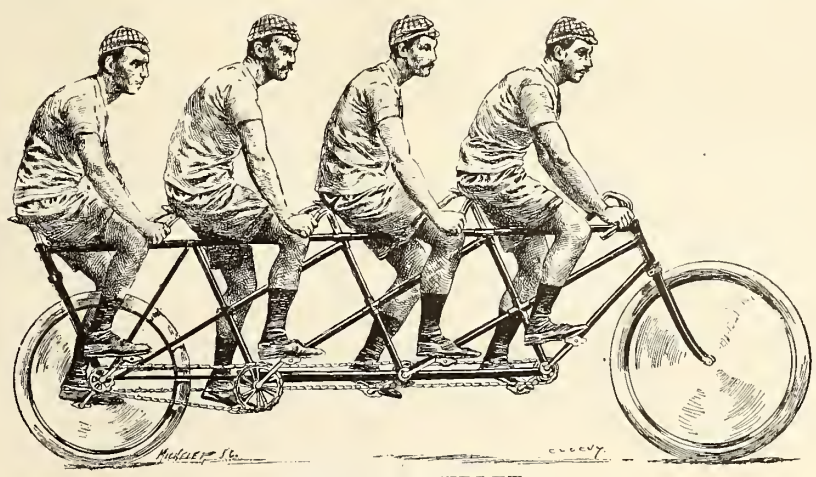
The running machine has not alone the monopoly of speed, for we find, likewise, at the exhibition a bicycle that makes its eight meters per revolution of the pedal, but let us add that it is ridden by four persons. It is the "Quadruplet." It is nearly three meters in length, and its weight, inclusive of that of the riders, is 300 kilogrammes. The pedals, set in the same direction, give an intensity of action similar to that of a crew of oarsmen. Under such an impulsion the machine acquires a vertiginous velocity.

The Quadruplet is too new to make it possible to consider its future. Up to the present it has served rather as a training machine, especially in England, where it has permitted of lowering short distance records (one mile or a half a mile) by a few seconds.

It was at the time of the recent match between Corre and Stephane that the first model constructed in France made its appearance, but the inexperience of the racers called upon to steer this new machine, designed to carry the two matchers, and the slight solidity of the flooring of the track, which threatened to give way under its weight, caused it to be immediately retired from the race.

Who would dare assume the responsibility of allowing such machines to run upon a roadway at speeds capable of reaching, at times, more than forty kilometers per hour? What terrible consequences to be considered in case of accidents, falls or collisions rendered almost inevitable, seeing the difficulty of steering surely at such velocities!

Alongside of the machines that develop the greatest speed, it is interesting to present by antithesis, so to speak, those that give the least. In the first place, it is a tricycle whose movement is combined for obtaining a minimum of effect. Devised by Mr. Meyan, it is to be used upon the new ring of the Eden theater for



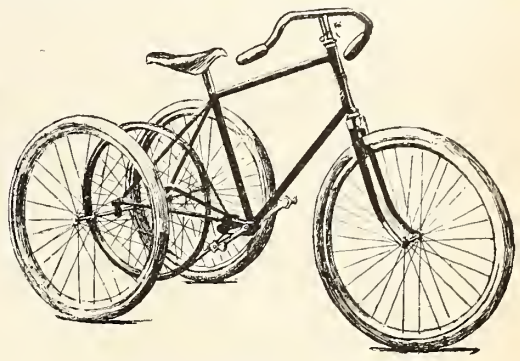
THE QUADRUPLET.

races that may be qualified as paradoxical. Without having any analogy with sport, they will nevertheless not be devoid of attraction. Here, the space covered per revolution of the pedal is no more than fifteen centimeters! One may judge in imagination of the fantastic efforts necessitated for recovering from a competitor an advance of fifty centimeters; of the incredible energy, as well sustained as in one of our best champions, that it will require to obtain a speed of three kilometers per hour; and of the spirit of the final spurt at the home pole in order to beat an adversary by a few centimeters! In a word, it is a parody upon our actual races.

Contrary to what is found in ordinary tricyles, in which the cranks actuate a large sprocket wheel that transmits the stress, through a chain, to a smaller sprocket wheel, fixed to the axle of the driving wheels, it is a small sprocket wheel here that actuates a large one nearly equal, in diameter, to the wheels of the machine. Owing to the slight velocity that results from such an arrangement, the system, by reason of the instability of equilibrium, can be applied to tricycles only.

Who would have said that cycling would prepare for us striking contrasts? After putting in parallel for us the swiftest and the slowest machines, it offers us the "Veloroom," an apparatus upon which a person, while exerting the same stress as before, remains *in situ*. It is, as its name is intended to indicate, a parlor cycle. As the saddle, pedals and handle bar are fixed to a frame mounted upon a support, the results are wholly Platonic. There are no overthrows to be feared, no risks to be run, the equilibrium is stable and the danger is *nil*, for the most furious kicking of the pedals produces no influence except upon the needle of a kilometric counter that mechanically registers the distance that would have been made in reality. So the apparatus appears to recommend itself more particularly to persons by whom, on account of obesity, the use of any bicycle or tricycle whatever is rendered impossible.

Specialized in cycling, the new home trainer may,



SLOW SPEED TRICYCLE.

during the inclement season, prove an excellent training instrument for racers.

Upon the whole, the exhibition presents to us four novelties, contrary to each other as to results, and that are destined to show their capabilities this year.—*L'Illustration.*

[Continued from SUPPLEMENT, No. 950, page 15177.]

## THE ART OF BOOK AND NEWSPAPER ILLUSTRATION.*

By HENRY BLACKBURN.

*Lecture II.*

LAST week we saw on the screen a number of enlargements of drawings which had been reproduced successfully by the common relief processes, suitable for the type press. The most interesting and suggestive to students were those drawn by painters, each adopting his own method of expressing, in black and white line, the effect and spirit of his picture. The result in most cases showed a freedom of handling, and an unconventional treatment of line drawing to give tones and values, in striking contrast to the majority of process work. Some of these were only sketches, and on various kinds of paper or board; but the artists knew what they wanted to express, and took the readiest and simplest method to attain it. They had dwelt for months on their subject, they knew the picture by heart, as the saying is; hence the value to us of their suggestive lines. These drawings (examined with the results when reproduced) form together, I believe, the soundest teaching in black and white work.

Let us now look at a pen drawing by Mr. H. S. Marks, R.A., and explain shortly the method of its reproduction. This drawing [here enlarged on the screen] was about 7 in. by 5 in.; it is thoroughly suitable for reproduction on a much smaller scale (say 3 in.) if necessary. Here every line tells, and none are superfluous; the figure of the monk, the texture of his dress, the door behind him, and the grass growing between form a picture, the lines of which harmonize well with the type of a book. In this deliberate, careful drawing, in which white paper plays by far the principal part, the lighting of the picture is considered, and the balance of a decorative page; a scientific example of the art of leaving out—of "the value of a line."†

Drawings thus made, upon Bristol board or paper

* Three lectures delivered before the Society of Arts, London, December, 1893. From the *Journal* of the Society.

† The young "pen and ink artist" avoids backgrounds, or renders them by a series of unmeaning scratches; he does not consider enough the true "lighting of a picture," as we shall see further on.

of that surface, with black ink, Indian ink, or any of the numerous inks now in use, which dries with a dull, not shiny, surface, will always reproduce well. The pen should be of medium point, or a brush may be used as a pen. The lines should be clean and sharp, and are capable of much variation in style and treatment, as we saw in the various examples last week. I purposely do not dwell here upon some special surfaces and papers by which extraordinary effects may be produced sometimes by the line processes; there is too much tendency already with the artist to be interested in the mechanical side.

### PHOTO-ZINC PROCESS.

Now, to turn the drawing before you into a suitable block, the first process is to photograph it to the size required (say 5 by 4), and transfer the negative on to a sensitized zinc plate. This print or photographic image of the drawing lying upon the zinc plate is of greasy substance (bichromate of potash and gelatine), and is afterward inked up with a roller; the plate is then immersed in a bath of nitric acid and ether, which cuts away what were the white parts on the paper, leaving the lines of the drawing in relief. This "biting in," as it is called, requires considerable experience, according to the nature of the drawing. Thus the lines are turned into metal in a few hours, and the plate, when mounted on wood to the height of type letters, is ready to be printed from, if necessary, at the rate of several thousands an hour.

The best drawing for process reproduction is one that requires little or no touching on the part of the engraver or maker of the blocks; but it is difficult to impress on the artistic mind the necessity of conforming to certain rules. Some cannot draw firm, clean lines at all, and *should not attempt them*. Few allow sufficiently for the result of reduction, and the necessary thickening of some lines.* The results are often a matter of touch and temperament. Some artists are naturally unfitted for line work; the rules which would apply to one are almost useless to another. Again, there is a great inequality in the making of these cheap zinc blocks, however well the drawings may be made; they require more care and experience in developing than is generally supposed.

### GELATINE RELIEF PROCESS.

Let us look now at the enlargement of a line drawing which is more difficult to reproduce; a portrait by the late Frank Holl, R.A. (drawn on Whatman paper, 4½ in. by 3½ in.), in which there are many pale, uncertain, and complicated lines which could not be produced well by the process just described. Here a more delicate and sensitive method is necessary to obtain a relief block. It is called the "gelatine process," or the "Gillot process."

The drawing is photographed to the required size (as before), and the *negative* laid upon a glass plate (previously coated with a mixture of gelatine and bichromate of potash). The part of this thin, sensitive film exposed to the light is absorbent, and when immersed in water swells up. The part protected from the light by the lines of the drawing remains near the surface of the glass. Thus you have a negative from which a metal cast can be taken, leaving the lines in relief as in the zinc process. In skillful hands this process admits of more delicate gradations, and the pale, uncertain lines in the drawing before us can be reproduced with tolerable fidelity. The blocks take longer to make, and are double the price —roughly, 1s. per square inch—of the first process described. There is no process yet invented which gives better results from a pen and ink drawing for the type press. These blocks when completed have a copper surface. The reproductions of pencil, chalk, or charcoal drawings by the above processes are nearly always failures, as we may see in the best artistic books and magazines to-day. I will refer to them presently.

For those who cannot draw easily with the pen, there are several kinds of grained papers which render drawings suitable for reproduction. The first is a paper with black lines imprinted upon it on a material suitable for scraping out to get lights, and strengthening to get solid blacks. The drawings thus made can be reproduced in relief like line drawings, taking care not to reduce the black grain much or it becomes "spotty." Another paper largely used has a white grain, a specimen of which I will show you presently on the screen; and there are other variations of grained papers on which we will not dwell †.

Here the question may arise in many minds, Are these contrivances, with their mechanical lines for producing effect, worthy of the time and attention which has been bestowed upon them? I think it is very doubtful if much work ought to be produced by these means; and certainly in the hands of the unskilled, the results would prove disastrous. A painter may use them for sketches. Mr. Compton, as you see, can express very rapidly, by scraping out the lights and strengthening the darks, a snow drift or the surfaces of a glacier. The late C. J. Watson and the French artist, M. Bistagne, have shown us how the white grained paper can be played with, in artistic hands, to give the effect of a picture in a quarter of an hour. [Reference to enlargements on the screen.]

### MECHANICAL DOTS.

The increased use of mechanical dots to give shadow and color to a pure line drawing is always to be regretted, whether it be applied to a necessarily hasty newspaper sketch or to one of Vierge's handsomely printed illustrations for the "Pablo di Segovia." One cannot condemn too strongly this system, so freely used in Continental illustrated sheets, which, in the most skillful hands, seems a degradation of the art of illustration. These dots and lines, used for shadow or tone, are laid upon the plate by the maker of the block, the artist indicating, by a blue pencil mark, the parts of a drawing to be so manipulated; and as the illustrator has not seen the effect on his own line drawing, the results are often a surprise to every one concerned. I wish these ingenious contrivances were more worthy of an artist's attention. Nothing but the speed with which a sketch for a newspaper can be thus made seems to excuse its use. Hurry is the secret and the mischief of it all.

Here is an example taken from an English print, by which you see that all daylight has been taken ruthlessly from an open air sketch. The system is tempting to the hurried illustrator; he has only to draw in line (or outline, which is worse), and then mark where the tint is to appear; and the dots are laid on the zinc plate by the maker of the blocks.

In the enlargements before you (referring to two examples from the *Daily Graphic*, one partly and one wholly covered with dots) it will be obvious that the artist's sketch is injured by this treatment, that in fact the result is not artistic at all. Nothing but high pressure or incompetence on the part of the illustrator can excuse this mechanical appliance to an incomplete drawing. Again I must remind you that these results are not the fault of the "process," or of the "process man." But the system is growing in every direction to save time and trouble, and is lowering the standard of topical illustrations. And it is this system (*inter alia*) which, I believe, is to be taught in technical schools, where the knowledge of process is taking the place of wood engraving.*

The question is again uppermost in the mind, are such mechanical appliances ("dodges," I venture to call them) worthy of the serious attention of artists; and can any good arise in imparting such knowledge to youthful illustrators in technical schools? Wood engraving was a craft to be learned, with a career for the apprentice. *There is no similar career for a lad by learning the "procesess" at technical schools;* and nothing but disappointment before him if he learns the mechanism before he is an educated and qualified artist.

It should be mentioned that all wood or steel engravings reproduce easily by the common zinc line process, but the reproductions are apt to lose brightness, and if much reduced break up or become spotty. Mention should be made also of drawing on prepared transfer paper with autographic ink, which is transferred to zinc without the aid of photography, a process very useful for rapid and common work; but it is irksome to the artist and not capable of very good results; moreover, the drawing has often to be minute, as the reproduction has to be the same size as the original.

### HALF-TONE PROCESS.

I now come to the method of reproducing wash drawings and photographs; on blocks suitable for printing at the type press, commonly known as the Meisenbach or "half-tone process;" a most ingenious and valuable invention, which, in clever hands, is capable of artistic results, but which in common use has cast a gloom over our illustrations in books and newspapers.

Now, to make these blocks; as there are no lines or whites in a painting, or from a photograph from nature, it is necessary to obtain some kind of grain, or interstices of white, on the zinc plate, as in a mezzotint. So between the drawing or photographic print to be reproduced and the camera, glass screens, covered with lines or dots, are interposed, varying in strength according to the light and shade required; thus turning the image of the wash drawing practically into "line," with sufficient interstices of white for printing purposes.

Thus, all drawings in wash, chalk, pencil, etc., that will not reproduce by the direct line processes, already referred to, are treated for printing at the type press, and thus the uniform, monotonous dullness with which we are all familiar pervades the page.

The artist who draws in wash with body color, or paints in oils in monochrome, for this process, will see at once that his high lights will be lost, and his strongest effects neutralized, under this effect of gauze; in short, that there is no longer any breadth of white or black in his picture; and so for pictorial purposes, the illustrator who draws in wash has to *force his effect*, and exaggerate his lights and shades, avoiding too delicate gradation; and in his different tints keeping, so to speak, to one octave instead of two. Thus, also for this process, to obtain brightness and cheap effect, the illustrator of to-day often avoids backgrounds altogether.

Some excellent results (which I will show you presently on the screen) may be obtained by experienced and practiced draughtsmen, if their work is well reproduced with a fine grain, and printed carefully on good paper. But where the block has to be prepared for printing, say 5,000 an hour off rotary machines, a coarser grain has to be used, producing the "Berlin wool pattern" effect you see before you.

There are many ways by which drawings unsuitable for the relief-toned processes are made available. Great advances have been made in the "screening" of pencil drawings where a great deal of white has to be left. You may trace the screening on every part of the enlarged proof before you. [Reproduction of a pencil sketch by Mr. Melton Prior.] These two wash drawings by Mr. S. Begg and Mr. Greville Manton, which have appeared lately in the *Black and White* newspaper, are good examples of the way to draw for reproduction; the artists have, you will notice, met the process half way, they have been careful to use broad, clear, firm washes, and they have done them with a certain hand, the result of experience. If, in the endeavor to get the best results out of a few tones by the mechanical process, their work lacks some artistic qualities, it is almost a necessity; but the tendency of this most modern form of illustration is to think too much of *technique*. But with the utmost care and patience on the part of the artist, these wash drawings, rendered by the half-tone process, are uncertain and artistically incomplete. It is more suitable for the rendering of sketches. Of the illustrators who use this process in a more free and easy way we will now take an example [an enlarged wash drawing was shown upon the screen].

Here truths of light and shade are disregarded, figures stand out in unnatural blackness against white paper, and flat mechanical shadows are cast upon nothing. Only sheer ability on the part of a few modern illustrators has saved these coarse ungainly sketches from universal condemnation. But the splashes, and spots, and stains, which are taking the place of more serious work in illustration, have become a vogue in 1893. The sketch is made in two or three hours, instead of a week; the process is much cheaper than wood engraving. The public is satisfied with a sketch where formerly a finished illustration was required, if the subject be treated dramatically and in a lively manner. If it comes out an unsightly smear on the page, it answers the purpose of topical illustration, and, apparently suits the times. It is scarcely too much to say that this example would not have been tolerated a few years ago. But it is the taste of the times to which the modern illustrator has adapted himself; and it is little short of a revolution in illustration, of which we do not yet see the end. One thing we must continuously bear in mind, that these hastily produced blotches called illustrations, which disfigure the pages of so many books and magazines, are the result of want of care on the part of the artist rather than of the maker of the blocks. The latter are, according to my experience, the most patient and painstaking of operatives.

The result of all this—a very serious one to the artist as far as we can see ahead—is the gradual substitution of photographs from life for any other form of illustrations. The Meisenbach reproduction of a photograph I now show you [the full length figure of the lady mayoress, photographed by Messrs. Russell, of Baker street] answers the purpose of the editor of a newspaper to fill a page of his paper, where formerly artists and engravers would have been employed. The excuse for it is that the details of the dress are so well rendered on the block as to answer the purpose of a fashion plate, apparently a most important matter.

Now let us see what becomes of a very artistic photograph when put through the half tone process. Here is the photographic print from a painting by M. Jules Lefebre [portrait of girl reading, shown on the screen]. This excellent silver print, full of delicate gradations and strong effects, appears on the plate through the film of gauze, dull, flat, and comparatively uninteresting; but the expression of the original is given with more fidelity than could be done by any ordinary wood engraving. To touch this on the negative and bring out the lights and accents of the picture is the common thing to do by the makers of the blocks; but it is a hazardous process at the best, when dealing with the copy of a painting. I mention it to show where handwork in the half tone process first comes in. The block, when made, is also often touched up by an engraver in places, especially where spotty or too dark; on this work many who were formerly wood engravers now find employment.

But the ideal illustration by process, whether from a line drawing, wash, or photograph, it cannot be repeated too often, is the one which requires the least manipulating on the part of the maker of the block, who has seldom, or never, the opportunity to attend to it properly. In the case of the reproduction of photographs, especially, which we are now considering, much may be done by working up a platinotype before giving it out to be made into a block. Much depends here upon the artistic knowledge of editors and publishers, who have it in their power to produce good or bad illustrations from the same original. The makers of these blocks being confined to time and price, are practically powerless.

Here let us pause for a moment to consider the material of which one number of an illustrated paper (*Sketch*) is made up, and how far the artist and wood engraver has part in it. It will be instructive from an economic point of view. I take a copy of *Sketch* because it is a typical and quite "up to date" publication, vying, in circulation and importance, with the *Illustrated London News*, both published by the same proprietors. In one number there are upward of 30 pages, 10 being advertisements. There are in all 151 illustrations, of which 63 appear in the text part and 88 in the advertisement pages. Out of these text illustrations, 24 are from original drawings or sketches. Next are 26 photographs from life (several being full pages), and 13 reproductions from old engravings, etc., reproduced by mechanical processes—in all 63. Some of the pages reproduced from photographs are undeniably good, and interesting to the public, as is evidenced by the popularity of this paper alone. In the advertisement portion are 88 illustrations (including many small ones), 85 of which have been engraved on wood; a number of them are electrotypes from old blocks, but there are many new ones every week. The reason for using wood engraving largely for advertisements is, that wood blocks print more easily than "process," when mixed with the type, and print better (being cut deeper on the block) where inferior paper and ink are employed. But this class of wood engraving may be summed up in the words of one of the craft to me lately: "It is not worth £2 a week to anybody." (I will refer to the better class of wood engraving when speaking of books next week.)

Thus, it will be seen that, in the "text" part of this newspaper, two-thirds of the illustrations have been produced without the aid of either artist or engraver!

To turn to other subjects where the photographer is the illustrator. The photographer goes down a mine with his apparatus, and takes a series of views of the workings, which could probably have been done by no other means. Under most difficult circumstances he sets his camera, and by the aid of the magnesium flash-light gives us groups of figures at work amid gloomy surroundings. Whether these are not both artistic and valuable as illustrations I leave you to judge. [Here two slides, taken in the Cambrian lead mines by Mr. J. C. Burrow, of Camborne, were shown, and others were exhibited on the walls.] The remarkable part, artistically, is the good color and grouping of figures. One great value of these illustrations consists in the clear

* All drawings for reproduction should be marked in the margin by the artist as to the amount of reduction intended. It is a useful guide to all concerned in publication.

† Mr. C. G. Harper, in his excellent book on "English Pen Artists," has treated of other ways in which drawings on prepared papers may be manipulated for the type press.

* The rendering of a chalk or pencil drawing into a relief block, to be printed on rapid machines with inferior paper and ink, is another branch of process which I think the student of art had better not know much about, for the process has never been successful under the best conditions. He would be better occupied in learning drawing on stone, an art which does not come into the scope of these lectures, as it is seldom used in book illustration and cannot be printed at the type press.

It is well worthy of study now, for the art is being revived in England on account of the greater facilities for printing than formerly. It is possible to obtain excellent results from chalk and pencil drawings in intaglio; photographed and printed as a copper plate; as may be seen in the specimens by the Autotype Company on these walls.

definition of detail. These photographs are shortly to be published in a book by Mr. Burrow and Mr. Thomas.

Another instance of the use of photography in illustration. Mr. Frederick Villiers, the special artist at Chicago for the *Black and White* newspaper, made a startling statement lately in this room. He said that out of some 150 subjects which he took in Chicago not more than half a dozen were drawn by him; all the rest being "snap shot" photographs. Some were very good, could hardly be better, the result of many hours' waiting for the favorable grouping of figures. That he would redraw some of them with his clever pencil for this newspaper is possible, but observe the part photography plays in the matter. I could mention many instances where the photographer and his models are producing illustrations of a dramatic kind, a system which cannot be ignored. (In America a novel has been thus illustrated both in figure and landscape.)

The last example of the photographer as illustrator, which can be given here, is where a photograph from life engraved on wood is published as a vignette illustration. [Slide from the *Graphic* of 28th of October, 1893.] It is worth observing because it has been turned into line by the wood engraver, and serves for printing purposes as a popular illustration. The original might, perhaps, have been more gracefully posed, and the effect may be to a certain extent "a fluke," but it is pretty as a vignette, and pleases the public. There are hundreds of such subjects now produced by the joint aid of the photographer and the process engraver.

Here we may observe that it is not the artist and the wood engraver who are "working hand in hand" in the production of the great majority of illustrations, as in America, but the photographer and the maker of process blocks. This is significant. Happily for us there is much that the photographer cannot do pictorially. But the photographer is, as I said, marching on and on, and the line of demarkation between original and photographic illustrations is less marked than formerly.

The photographer's daughter goes to an art school, and her influence is shown clearly in the exhibitions of the photographic societies. This influence and this movement is so strong—and vital to the artist—that I feel it cannot be emphasized too much. The photographer is ever in our midst, correcting our drawing with facts and details which no human eye can see, and no one mind can take in at once.

Of the obligations of artists to photographers a book might be written. The benefits are not, as a rule, unacknowledged; nor are the bad influences of photography always noticed. That is to say, that before the days of photography, the artist made himself acquainted with many things necessary to his art, for which he now depends upon the photographic lens; in short, he uses his powers of observation less than he did a few years ago. That the photographer leads him astray sometimes is another matter.

Whatever developments may await the art of photography, says Mr. William Small, in 1893, "it will never take good work out of a good artist's hands. In line work (the best and surest for the processes) photography can only be the servant of the artist, not the competitor—and in this direction there is much employment to be looked for. But in whatever material or style, newspaper illustrations, to hold their own, must be of the best. Let them be as slight as you please, if they be original and good. At present we are casting off—ungratefully it would seem—the experience of the lifetime of the wood engraver, and are setting in its place an art half developed, half studied, full of crudities and discords. The illustrations which succeed in books and newspapers succeed, for the most part, from sheer ability on the part of the artist; they are full of ability, but, as a rule, are bad examples for students to copy. "Time is money" with these brilliant executants; they have no time to study the value of a line, nor the requirements of the processes, and so a number of drawings are handed to the photo-engravers—which are often quite unfit for mechanical reproduction—to be produced literally, in a few hours. It is an age of vivacity, daring originality, and reckless achievement in illustration. "Take it up, look at it, and throw it down," is the order of the day. But there is no reason, but laziness, why the work done "to look at" should not be as good as the artist can afford to make it. The manufacturer of paper hangings or printed cottons will often print only a limited quantity of one design, no matter how beautiful, and then go on to another. So much the better for the designer; but he would not keep employment if he did not do his best, no matter whether his work is to last for a day or for a year. The life of a single number of an illustrated newspaper is a week, and of an illustrated book about a year.

The young illustrators on the *Daily Graphic*—notably Mr. Reginald Cleaver—obtain the maximum of effect with the minimum of lines. Thus Caldecott worked, spending hours sometimes studying the art of leaving out. Charles Keene's example may well be followed, trying drawing after drawing, no matter how trivial the subject, until he was satisfied that it was right. "Either right or wrong," he used to say; "'right enough' will not do for me."

Another influence on modern illustrations—for good or bad—is the electric light. It enables the photographic operator to be independent of dark and foggy days, and to put a search light upon objects which otherwise could not be utilized. So far good. To the illustrator this aid is often a doubtful advantage. The late Charles Keene (with whom I have had many conversations on this subject) predicted a general deterioration in the quality of illustrations from what he called "unnatural and impossible effects," and he made one or two illustrations in *Punch* of figures seen under the then (10 or 15 years ago) novel conditions of electric street lighting, one of which I will show you on the screen. [Illustration of a gentleman who has been dining, returning home through a street lighted by electric lamps.] Charles Keene's predictions have come true. We now see the glare of the magnesium light on many a page, and the unthinking public is dazzled every week in the illustrated sheets with these "unnatural and impossible effects." Thus it has come about that what was looked upon by Charles Keene as garish, exaggerated, and untrue in effect is accepted today by the majority of people as a lively and legitimate method of illustration.

### PROCESS BLOCK MAKERS.

I must mention one more influence on the young illustrator. The "process man," the teacher and inciter to achievements by this or that process, is not usually an "artist" in the true sense of the word. He knows better than any one else what lines he can reproduce, and especially what kind of drawing is best adapted for his own process. He will probably tell the young draughtsman best what materials to use, what amount of reduction his drawings will bear, and other things of a purely technical, not to say business-like character. Let me not be understood to disparage the work of photo-engravers and others, engaged on these processes; on the contrary, the amount of patience, industry, activity, and anxious care bestowed upon the reproductiou of drawings at the present time is astonishing and deserves our gratitude. Their work in England is a new industry of an important kind, in which art and craft are bound together. The photo-engravers are our faithful friends, and are ready to serve us well, if only the public (represented by editors and publishers) will recognize that *good work requires good pay.* The day has passed when "process work" is to be looked down upon as only fit for the cheapest, most inferior and inartistic results.

There is no doubt that the makers of process blocks are the best instructors as to the results to be obtained by certain lines and combinations of lines; but in the majority of cases they will tell the artist too much, and lead him to take too much interest in the mechanical side of the business. His best protection against this tendency, his whole armor and coat of mail, is *to be an artist first and an illustrator afterward.*

This is the sum of the matter. Perhaps some of the examples I have brought here to-night may help us, and lead to a more thorough testing of results by capable men.

## THE JOULE MEMORIAL STATUE.

MANCHESTER claims the distinction of having been the home of two of our greatest men of science—Dalton and Joule—and it has shown itself worthy of the honor. A beautiful statue of Dalton has adorned the vestibule of the Town Hall for some years, and on Dec. 8, 1893, one of Joule, by Mr. A. Gilbert, was unveiled in the same place, the two philosophers standing face to face.

The unveiling of the Joule statue was performed by Lord Kelvin, in the presence of a large company. The *Manchester Guardian* gives a full report of the proceedings, and from it we extract the following remarks made by Lord Kelvin in the course of his address.

The Literary and Philosophical Society had the distinguished honor of being really the cradle of Joule's work—first as Dalton's home and afterward as Joule's lifelong scientific harbor. From very early days he kept constantly in touch with that society. Many of his most important papers were first given to the world there, and during the last years of his life he was an exceedingly regular—it might almost be said a constant—attendant at the meetings of the society. The citizens of Manchester did not require to be told what great things this society in its rather more than a century's existence had done. Their presence in such numbers on that occasion showed how much they appreciated the results of that very effective scientific institution. Now he ought to say something of the electrical, mechanical, and chemical character of Joule's work, although to examine it properly would require the space, not of one address, but of a whole course of lectures, illustrated by experiments. A great surprise that came out very early in Joule's work was burning without heat—an absolutely novel idea which Joule developed most wonderfully and most magnificently by his experiments in the generation of heat in the voltaic battery, which in those days was the only source of electricity on a large scale. Joule was the first to develop the idea, and it came to him, not as a bright flash of genius, but as the demonstrated result of years of hard, measuring, calculating work. This was the fundamental idea that pervaded all Joule's work. A few years later he expanded it in a wonderful way. About 1846, in a joint paper by himself and Scoresby, he brought out the wonderful, the truly philosophical, and at the same time startling idea that when a man or any other animal walked uphill only a part of the heat or combustion of his food was developed, and that it was when the body was quiescent that the chemical attraction between the food and the oxygen dissolved in the blood developed its whole energy in actual animal heat. He showed, further, that the animal body was more economical for fuel than was any steam engine hitherto realized. This was a very far-reaching idea, and seemed to hold out prospects of greatly advancing the efficiency of the steam engine. That promise had not been lost. It was due to Joule, more than to any other individual, that the great improvement of surface condensation was now universal, although very rarely practiced, indeed, before 1860 or 1862. Joule, about the year 1860, in working upon a little steam engine, applied a surface condenser on an entirely new principle, and in doing so he was led to think out a mode of getting heat out of the steam to be condensed without sending a jet of water into it, as on the old plan. But he (Lord Kelvin) had not yet touched upon Joule's great fundamental discovery, the discovery which was first in every one's mouth—that of the mechanical equivalent of heat. They would understand that it was not merely by a chance piece of measurement that he stumbled on this result, which was afterward found to be of great value. It was measurement, rigorous experiment and observation, and philosophic thought all round the field of physical science that made this discovery possible. Very early indeed in his working time Joule brought out the mechanical equivalent of heat, and in a paper read at the British Association at Cork in 1843, and afterward in the *Philosophical Magazine*, he gave the number "772." Six years later a second determination gave him the same result, and twenty-five years later he made a third determination, which gave him the final and corrected result "772·56."

In the year 1824 a great theory was originated by a very young man who died only a few years later—Sadi Carnot, son of the republican minister and uncle of the present President of the French republic. It was he who made "Carnot's theory" a household word throughout the world of science; and great as was the French president, much as he had done for his country and the world, in after-times his uncle would be always remembered as one of the most distinguished characteristics attached to that great name. Carnot's theory gave an important fundamental principle regarding the development of motive power from heat. Joule's work, on the other hand, so far as the mechanical equivalent was concerned, was the generation of heat by mechanical work. It was quite the middle of the century before Carnot's work began to attract attention; but Joule was early made acquainted with it, and after fighting a little against it as differing from his own theory, he of all others took it up in the most hearty manner.

Lord Kelvin went on to say that he could never forget the British Association at Oxford in the year 1847, when in one of the sections he heard a paper read by a very unassuming young man who betrayed no consciousness in his manner that he had a great idea to unfold. He (Lord Kelvin) was greatly struck with the paper. He at first thought it could not be true, because it was different from Carnot's theory, and after the meeting he and the reader of the paper, James Joule, had a long and thoroughly discursive talk on the subject, and he obtained ideas he had never had before, although he thought he, too, suggested something worthy of Joule's consideration when he told him of Carnot's theory. He had the great pleasure and satisfaction for many years, beginning just forty years ago, of making experiments along with Joule, which led to some important results in respect to the theory of thermodynamics. This was one of the most valuable recollections of his life, and was indeed as valuable a recollection as he could conceive in the possession of any man interested in science. Joule's initial work was the very foundation of our knowledge of the steam engine and steam power. Taken along with Carnot's work, it had given the scientific foundation on which all the great improvements since the year 1850 have been worked out, not in a haphazard way, but on a careful, philosophical basis.

James Watt had anticipated to some degree in his compound engine and his expansive system the benefits now realized, but he was before his time in that respect, and had the complete foundation which Joule's mechanical equivalent and Carnot's theory had since given for the improvement of the steam engine. Might he be allowed, Lord Kelvin added, to congratulate the city of Manchester on its proceedings that day? When the cover was lifted from the statue of Joule he felt deeply touched at the sight of the face of his old friend. To his mind it was a most admirable likeness, and the ideality of the accessory of the little model held in the hand seemed to him most interesting and most striking—he thought he might say poetical. That little model was not one of Joule's first or second, but of his third and greatest apparatus for the determination of the mechanical equivalent of heat—that by which he corrected the British Association's standard ohm, which he proved to be 1·7 per cent. wrong. Regarding that standard, a diplomatic correspondence was now going on between our Foreign Office and other European governments with a view to arranging the precise terms of the definition of the ohm, which was really first worked out by Joule.

Lord Kelvin further asked to be allowed to congratulate the sculptor on the great beauty and the great success of his work, and added that Manchester now possessed statues both of the man who laid the foundation of the atomic theory in chemistry and of the man who was the originator of the whole subject of thermodynamics. If the prosperity of Manchester did not depend on chemistry and on the steam engine and thermodynamics, he did not know upon what it did depend. The energy and industry of its inhabitants were no doubt essential to its success, but they must ever remember that the material prosperity of the city was as much dependent on philosophic thought as it was upon any material appliance whatever.

Sir H. E. Roscoe, M.P., in moving a vote of thanks to Lord Kelvin for his address, mentioned that for thirty years he himself sat at the feet of Joule, whom he might therefore claim in some sense as his scientific father. He remained in constant communication with Joule up to the day of the philosopher's death. It was a great thing that in a city like Manchester, devoted as it was to industry and commerce, the citizens should be entitled to place in their Town Hall the statues of two such fellow-citizens as Dalton and Joule. Few cities in the world could boast of two greater men. In London, also, they had been doing something to show the appreciation in which not only this country but the world held Joule.

A sum of money had been raised and placed in the hands of the Royal Society for the purpose of founding a Joule studentship, and the council of the society resolved that the money should be spent in founding such a scholarship, to be awarded alternately in England and in other countries, for the purpose of encouraging young scientific men to walk in the steps of Manchester's great citizen. The first of those scholarships, of the value of £100, would be shortly awarded, and he thought he was not going too far when he said it would come to the city in which Joule lived and worked. He might mention that since the foundation of Owens College that institution could claim nine medalists of the Royal Society, and, had they lived, Prof. Jevons and Prof. Schorlemmer would have been added to the number. It would be seen, therefore, that Manchester had taken up the thread spun by Dalton and Joule, and that there was no reason to fear that their work would not be continued.

F. WATTS, of the Government Laboratory, Antigua, gives the results of the analysis of the ash of ripe St. Vincent arrowroot. The fresh root, when cleaned and scaled, yielded 1·219 per cent. of pure ash, carbon dioxide being deducted. This ash contained silica, 9·73 per cent.; phosphoric anhydride, 12·24; sulphuric anhydride, 6·39; chlorine, 6·48; oxide of iron, 0·22; alumina, 0·13; lime (CaO), 3·18; magnesia, 5·39; potash, 54·06; soda, 2·14. From these figures it is estimated that a fair crop of arrowroot would remove from the soil about 80 to 90 lb. of potash per acre. It is suggested that this should be replaced by a chemical manure, which should also contain relatively small amounts of phosphate and nitrogen.

## ACCUMULATORS IN CENTRAL STATIONS.

OUR engravings are reproduced from a photograph of a storage battery installation made by the Electric Storage Battery Company at the station of the Germantown Electric Light Company, of Philadelphia.

This battery consists of one hundred and twenty elements of the chloride type, G, eleven plates each. They are installed on the three-wire system, and have a normal discharge rate of one hundred amperes on each side, and a capacity at this rate of 2,000 ampere hours.

The plates are protected by the improved asbestos insulation, and are contained in lead-lined wooden tanks set on glass insulators, and supported on strong supporting stands, painted with acid-proof paint, in four rows of two tiers each.

The special application of a battery in this instance is for the purpose of carrying the day load of the station for the commercial lighting and power circuit. The engines are shut down at daylight, and the battery carries the whole load until dusk, at which time it is thrown out of circuit, and is put into charge during the early morning hours, when the station load is light, and the cost of charging is practically nothing, as the machinery is more efficient, no extra labor being required during charge, and during discharge the working force of the station is considerably reduced, the battery requiring practically no attention.

The potential is maintained in discharge by the cutting in or out of reserve cells, six of which are used on each side.

The Germantown Electric Light Company, after over a year's experience with the chloride battery, has thoroughly demonstrated the advantages claimed for a storage battery for central station purposes.

In view of the large number of electric light stations in this country, which are to-day either running a day load at a loss or else furnishing no current at all during the daytime, the importance of demonstrating the advantages of applications of this character are clearly apparent, since a battery in such stations will not only wipe out the loss above mentioned, but show a very large profit, and enable the lighting company to furnish continuous service (Sundays included), which, of course, will be very much appreciated by their customers

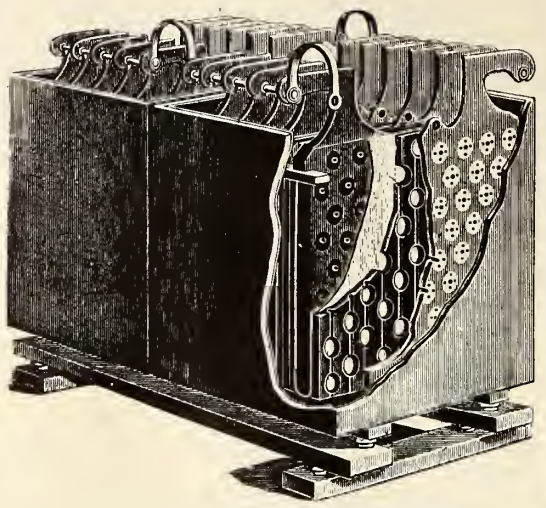
An electric light or power plant without an installation of storage batteries is like a gas works without a gas holder. Such a plant must be supplied with generating apparatus of capacity sufficient to supply the maximum demand; a demand which continues for not over one-sixth of the time—four hours out of the twenty-four. For the other eighteen hours of the day this large generating plant is operated at only a fraction of its capacity, and, therefore, at a great loss.

It will be readily understood, therefore, how much greater will be the economy of a much smaller generating plant, operated up to its utmost capacity for the whole twenty-four hours in connection with a storing plant, which during the light load will store up the surplus output of the generating plant, and which will, during periods of heavy load, give out this stored energy to assist the generating plant in supplying the increased demand. In the event of a temporary stoppage of the generators, such an auxiliary plant can carry for a time the entire load. In many electric light stations the demand during one-half of the time is so light that it does not pay for operating the plant at all during such period, and so a source of much revenue is entirely lost, which could be secured if a storing plant should be installed. As a regulator of pressure in case of fluctuations in the load the value of a storing plant is inestimable.

These fluctuations of load are particularly noticeable in electric railway plants, where the demand is constantly rising and falling, sometimes jumping from almost nothing to the maximum, and *vice versa*, in a few seconds. If for no other reason than the prevention of severe strain on the engines and generators caused by these fluctuations of demand, a storage plant will soon pay for its installation. If placed at suitable points along the line, much of the feed wire system may be done away with, and a great improvement in equality of pressure secured.

Such auxiliary plants will act automatically, and require very little attention. In case of temporary stoppage of generators or of a break in the supply circuits the value of such a constant source of supply is most apparent. An installation of this kind may be arranged to carry the whole load when few cars are running late at night and early in the morning, and for operating an "all-night" line, which otherwise would not pay expenses.

By the installing of a storage plant many natural but small sources of power may be utilized in furnishing light and power; sources which otherwise are not



THE CHLORIDE ACCUMULATOR.

available, because not large enough to supply maximum demands. The force of the tides, of small water powers from irrigating ditches, and even of the wind, come under this heading. To all of these applications the chloride accumulator is particularly adapted because of its enormous storing capacity and demonstrated durability and efficiency.

In the city of Paris, France, alone there are over 100,000 electric lamps supplied by chloride accumulators, as well as a large amount of electric power.

The chloride accumulator can be furnished of any desired capacity by The Electric Storage Battery Company, of Philadelphia.

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[FROM THE NEW YORK SUN.]

## RUNNING A BIG HOTEL.

"Do you think you could run a hotel?"

"Simplest thing in the world, my dear sir. All you have to do is to rent a building, hire a clerk and a cook and some other help, charge your guests more than it costs to keep them, and there you are."

This really seems such a simple undertaking that in these times of financial fancifulness it is strange, since people must live in a hotel or elsewhere, and so many cannot live elsewhere, that more people do not adopt this easy method of accumulating wealth beyond the dreams of avarice. But when one comes to investigate the running of a big hotel, it is quickly discovered that this simple formula must be relegated to the limbo of that more celebrated one for easy accumulation of wealth in stocks: buying when they are low and selling when they are high. So a *Sun* man concluded after he had passed a day in studying merely the organization necessary to the running of a big hotel, without touching upon the thousand details of financing, economics, wear and tear and kindred subjects which turn hotel men's hair gray. The *Sun* man learned facts which go to show that running a hotel requires as much planning, organization, detail and executive ability as go into the successful building, launching and sailing of a first-class man-of-war, with one or two big naval battles thrown into the job.

The information was derived from Mr. Boldt, proprietor of the Waldorf, and his steward, Mr. Thomas M. Hilliard.

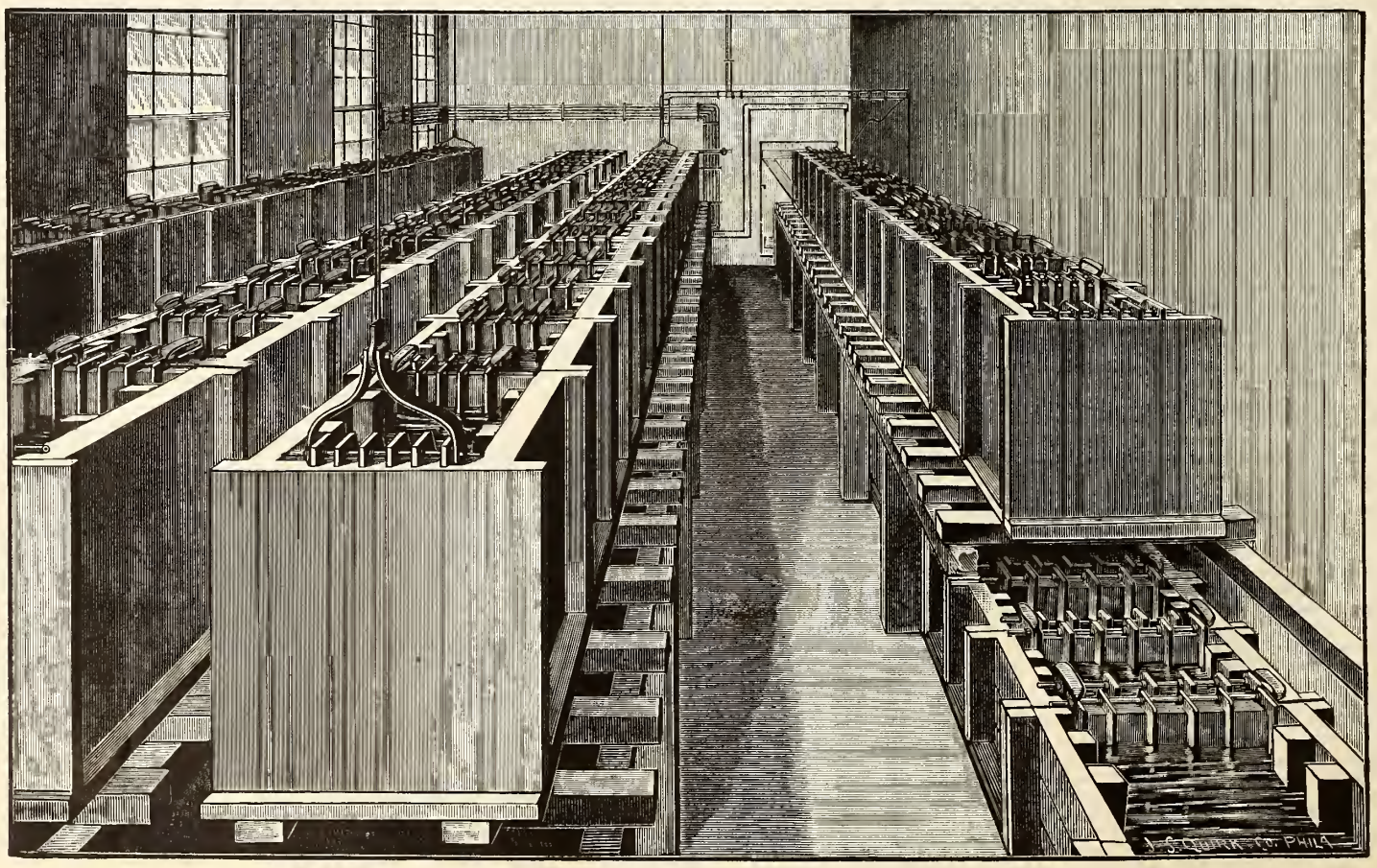
When Mr. Boldt was asked to give some facts about the organization of his staff and his army of four hundred employes, he called Mr. Hilliard to his assistance, and they together furnished the facts and figures given here.

The Waldorf organization, it should be stated first, differs somewhat from that of other large hotels. There is no officer in the organization known as the manager of the hotel. Mr. Boldt as proprietor is his own manager, and the officer next to him in the executive department is known, not as the hotel manager, but as the proprietor's manager. The other difference in the organization is in the greatly increased number of departments which come under the direct control of the steward, as will be seen further along. But these are only differences in detail; the story of the organization of the Waldorf is sufficiently like that required in any other very large hotel to prove the intricacy and variety of administration involved.

To begin, then, with the administration department. Mr. Boldt has his first assistant, who is known in the organization as his manager, and is the man in authority on the main floor when the proprietor goes out.

The main office force consists first of two room clerks. These officials must be men with absolutely no temper, but with vast capacities of judging human nature. Next come two bureau of information clerks, who were formerly known as "Front!" or key clerks, but they are more than that in the big modern New York hotel. They must not only be prepared to answer every possible question, from whether Barnum's show is still on the corner of Ann Street and Broadway to what is the most direct route to Timbuctoo, but they must be able to impart this information in a great variety of languages. There is a package clerk who conducts a carefully systematized delivery business, entering and checking every package, and requiring a receipt for every package delivered to guests. These, with two cashiers, a stenographer and three night clerks, make up the force in the main office with which guests come in personal contact. In an office upstairs there is a force of bookkeepers and clerks under the management of a comptroller where all the accounts of the hotel are kept. The comptroller has under him eight checkers, and the checks made out by each of these eight are in quadruplex, one of each going to a cashier, one to the department through which the check originated, one to the book of the comptroller, keeper of that department, and one is retained by the checker. The comptroller's force compare and verify these and keep the accounts arising through the various channels of purchase, pay roll, supplies, repairs and the multitude of details suggested as the story proceeds.

Returning to the first floor and the force which comes directly under the eye of the management, the first in evidence, to the entering guest at least, are the sixteen to twenty bell boys. In the Waldorf these bell boys are really only office messengers. They do not answer room calls, deliver cards or supply any service to a guest after they have shown him to his room. Their former varied duties have been replaced by the pneumatic tubes and the separate force of waiters on each floor. Aside from showing guests and visitors to rooms, they are kept busy by carrying the innumera-



STORAGE BATTERY INSTALLATION, GERMANTOWN ELECTRIC LIGHT COMPANY, PHILADELPHIA, PA.

ble orders which issue from the proprietor to the various departments.

Cards, telegrams, letters and messages of that sort are sent to the various floors from the office by pneumatic tube men, of whom there are two employed during the day and one at night. The head bell boy is busy at all times near the office desk standing by the side of the man on duty at the bureau of information, making a record of the name and time of all callers and the names of the persons called upon. The office floor force consists further of six door boys, two footmen, four "buttons," two telephone men, ten elevator boys, two starters, all of whom are, of course, in uniform, and three leisurely-looking ununiformed men who comprise the detective force.

The door boys open and close the entrance doors, the footmen open and close carriage doors, the "buttons" whisk the snow or dust off your coat, and at other times stand around looking ornamental, the elevator boys take you up to your floor when the starters have given them permission. The starters have a more important duty to perform, which is to watch the stairway. They act under positive instructions to permit no one to go up stairs without a written pass from the proprietor.

Mr. Boldt does not regularly designate any of his assistants to issue these passes, naming one person for that purpose each time he leaves the hotel. Even with a pass in his or her possession, a stranger cannot go up stairs unless accompanied by a hotel servant in livery. The reason for this rigid rule, and another rule which prohibits the exit of any person with a bundle from the entrance near Fifth Avenue leading into the restaurant, is obvious.

Outside the hotel doors, besides the footmen, there are two carriage starters on duty until 1 o'clock at night, two pavement men, who relieve Commissioner Andrews of the work of keeping the streets clean in front of the hotel, and a gardener who, besides keeping trim the garden strip on Fifth Avenue, attends to the plants in the garden cafe.

A very important personage not yet mentioned is the head porter; he has a first assistant and twelve baggage handlers under him: also four bootblacks and toilet room men, and four messengers. These messengers wear the hotel livery, but are for the message service of the guests outside of the hotel. That completes what may be called the office force, concerned with the work which comes immediately under the office direction.

The housekeeper's department is next most closely under the direction of the office. The head housekeeper is a woman who has two assistant housekeepers, one to look after chambermaids, one to look after the cleaners. There are thirty-six maids, eighteen cleaners, who are women, and six men window cleaners. In addition to these the housekeeper has under her direction six furniture movers, an upholsterer and his assistant, a furniture repairer and his assistant. In the housekeeper's linen room there are two seamstresses and two girls who check out clean linen in exchange for soiled. If a head waiter wants a hundred clean napkins, he can only get them in exchange for an equal number.

The laundry, which is also in the housekeeper's department, is run by a chief and one assistant, two machine men and thirty-seven laundresses. The housekeeper's force is completed by the four parlor maids who decorate the reception rooms on the lower floor.

With this enumeration is concluded the employes who are directly controlled by the proprietor and his personal staff. The proprietor manages every other department of the hotel through the man who seems to be really his chief lieutenant, the steward. The steward in turn has at least a dozen important departments under him. There is then the steward, who is personally aided by one first assistant, one bookkeeper, one receiving clerk and two timekeepers. The timekeepers have mechanical aids, because every employe in the house, excepting the men employed in the office, carries a key with which he starts a mechanical contrivance which keeps a record of his time.

The most important division controlled by the steward is that which in turn is under the direction of the chef. The chef has under him six deputy chefs; each of these being a specialist, one for roasting, one for sauces, one for vegetables, and so forth. Each of these deputy chefs has from two to three assistants, and there are also employed in the kitchen proper four men who do nothing but wash and scour the pots and pans used by the cooks, and two men who do nothing but wash the marble floor of the kitchen. Directly under the chef there are employed forty-five men—no women. In other rooms, not under the chef, are a pastry cook and two assistants, a chief baker and an assistant, a chief compounder of ices and ice cream and two assistants, and two girl helpers, whose delightful vocation it is to prepare raisins and other fruit for the pastryman. Continuing, in the general department where food is prepared for guests, there are, in another room, three oystermen, a coffee maker and two assistants, six storeroom girls, who give out lettuce, bread, butter, cheese, and so forth; two men, who supply the storeroom girls from the cold storage room; three yard men, who take the delivery of stores from dealers and distribute them to their various destinations. Then there is the big wine room in charge of a steward, assisted by four bottlers and handlers and five barkeepers.

Before going upstairs from the kitchen floor to where the food is served, it comes in proper rotation to speak of the big room known as "Help's Hall." That has a head waiter and ten women who wait on male and female employes, excluding waiters. Then there is the waiters' dining room, where four waiters are employed, and the mechanics' dining room, where two waiters are employed.

Just who waits on the waiters who wait on the waiters the *Sun* man failed to discover.

These numerous divisions and powers are necessary to supply the orders that come from five different sources, and that are grouped in the restaurant department, which is immediately under the *maitre d'hotel*, who, like the chef, is in the steward's domain.

The *maitre d'hotel* has under him the ladies' restaurant, the gentlemen's restaurant, the garden cafe, the private dining rooms and the floor waiters who serve orders to private apartments. In the ladies' restaurant there are a head waiter, three assistant head waiters, sixty waiters and twelve omnibuses. The latter are apprentice waiters, and are employed to remove dishes between courses and otherwise aid the waiters.

In the garden cafe there are two head waiters, fifteen waiters and five omnibuses. In the gentlemen's restaurant there are two head waiters, eighteen waiters and six boys. The private dining room force is merely a skeleton organization composed of a head waiter, four assistant waiters and two women, who wash by hand the fancy china used in the private rooms. This force is increased as the size and number of the private diners require. Meals are served in rooms by the floor waiters. On each floor there are a head waiter, a waiter and an omnibus always. This force, too, is increased as required. The floor waiters never go to the kitchen, their orders being supplied by the dumb waiter service.

In the ladies' restaurant, the big one on Fifth Avenue, there are six checkers and two cashiers, and in the other two smaller restaurants two checkers and two cashiers each. That completes the organization through which meals are served, except the interesting little operation which proceeds at the foot of the dumb waiter. This is on the kitchen floor. The dumb waiters are two hydraulic elevators. They can be operated only from the bottom, and two men alternate in watches at the ship-like wheel which is turned to start and stop them. When a tray has been placed on the elevator the operator touches a button which notifies the head waiter on the floor to which the tray is consigned, and then turns the wheel. As the elevator ascends an indicator marks its location, and another turn of the wheel stops it at the right floor. There was something vaguely humorous in the sight of the waiters who were serving course after course into those elevators. The waiters were dressed just as those in the restaurant, had to undergo the same inspection of their linen and finger nails; their trays had to be exhibited to a checker just the same, yet they never saw nor went near the people they were serving, and what is of more importance, the people there never "saw" them.

That ends the restaurant service, except that there is another active division required to care for the china and silver carried out to the pantries by the omnibuses. From the pantry men carry the dishes to the steam dish washers, where eight men are employed, and to the silver cleaner, where a chief and twelve assistants are employed. Dishes are washed by steam, knives cleaned by machinery and silver burnished by electricity. And, by the way, the humble bottle washers merely touch a button when they want something to revolve like lightning inside a bottle, and the ice cream man moves a lever when he needs another ton of crushed ice.

Before going into the mechanical department a few words more will conclude the list of those whose services are for the personal comfort of the guests. There are ten barbers, two ladies' hair dressers, one manicure, one chiropodist and two valets.

All the mechanical departments are under the steward's supervision. There is one chief engineer and two assistants (one for day and one for night). Each assistant chief engineer has four firemen, two oilers and one coal passer. There is one ice machine man and one tank man. No ice is used in the cold storage; the low temperature required for meats, vegetables, wine, milk and other stores is produced by cold air.

The machine shop, where all repairs to engines, pumps and elevators is done, is run by a master mechanic and two assistants. In addition the mechanical force includes one head painter and two assistants, two steam fitters, two plumbers, two carpenters, one electrician and two assistants. The plant operated by the last named furnishes 10,000 sixteen candle power incandescent lamps, and the twenty-seven pumps have a daily capacity of 3,000,000 gallons. You see what a simple thing it is to organize the force required to run a big modern hotel.

## THE PIEFFORT SPINET.

THE spinet, upon which the herdsmen and shepherds of the Vosges play those pretty airs that are so much enjoyed by tourists, was invented at an epoch that cannot be precisely stated, by Dorothea, an alleged sorceress, who lived in the Valley of Ajol, near Plombieres. This musical instrument, which is exhibited at the Museum of the Conservatory, consists of an elongated box provided at one end with a shoulder piece and at the other with a neck with wooden pegs, after the manner of a violin. It is made of the wood of the cultivated or wild cherry tree, and is provided with five sonorous strings—four *sols* in unison and one *do*. It is, upon the whole, a rudimentary instrument and one that possesses several serious defects, viz.: The pins to which the strings are fixed at the shoulder excoriate the player's finger, the steel strings are difficult to mount with simple wooden pegs, and, finally, the sonorousness, in consequence of the use of an ill-adapted wood and of a metal nut, leaves much to be desired. Into this primitive spinet, Mr. P. Pieffort has introduced important improvements. The addition of a new string in the basses completes the perfect accord, *la*, *do* sharp, *mi*, of the scale of *la*. The neck is provided with six keys with racks that permit of quick and easy tuning. A piece with a special string fastener does away with the inconvenience noted above. Finally, the sonorousness is greatly developed by the use of properly selected wood. After numerous experiments, Mr. Pieffort has found that the kinds of woods should be classified in the following order, beginning in this regard with the best: Rosewood, ebony, amaranth, blue ebony, false mahogany, walnut, cherry. This classification is somewhat surprising at first sight, but it must not be forgotten that, as has been observed by Mr. Pieffort, the sound is produced in the spinet by the repercussion of the sonorous waves, and not by their vibration in the interior of the instrument, as in the violin. As a proof in support of this, Mr. Pieffort has observed that the sonorousness is diminished by more than half when the spinet is placed upon marble or metal instead of wood.

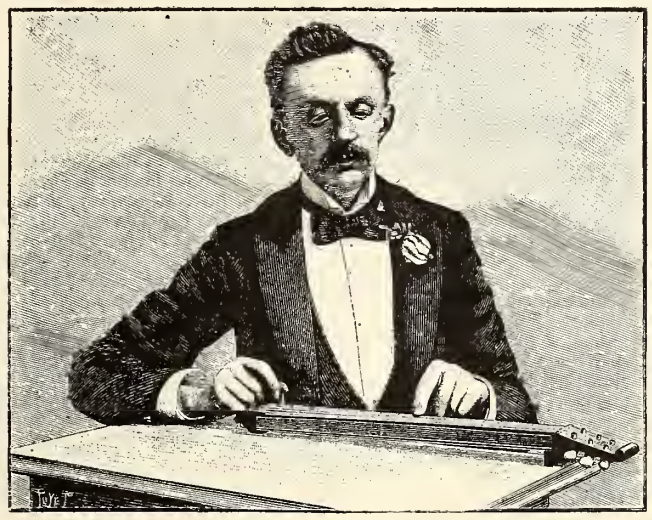


FIG. 1.—METHOD OF USING THE PIEFFORT SPINET.

The instrument, which is not very cumbersome, being placed upon a table, is played with the left hand armed with a piece of reed serving as a fingering stick, and the right with a mediator (a piece of tortoise shell), designed to cause the alternate vibration of the strings so as to obtain at will either a continuous sound, as in the mandolin, or pizzicati, as in the guitar. Slurred notes, which add so much to the expression, are easily executed. The natural tones and semitones of the scale are obtained on the two first strings, and the alterations (sharps and flats) upon those of the center, which serve at the same time to produce a note of perfect accord. The effects of choruses are produced by the simultaneous vibration of the six strings, giving the perfect accord. The Pieffort spinet permits of playing upon a range of two octaves and a half starting from *mi*, a sixth above the grave *sol* of the violin. With the special sonorousness due to the nature of the instrument and the physical effects that it produces, it lends itself to the execution of all pieces not exceeding this range. We have heard the inventor execute the stanzas of Flegier, a pavan of Louis XIII., the Ave Maria of Gounod, and Loin du Bal, a fantaisie on *Il Trovatore*, and we can say that the instrument lends itself to every *nuance* and is very agreeable to hear. The spinet, moreover, is very easy to play, and a person ignorant of music may, in a few hours, learn to execute certain popular airs, dances especially. It is an interesting invention worthy of being presented to our readers.—*La Nature.*

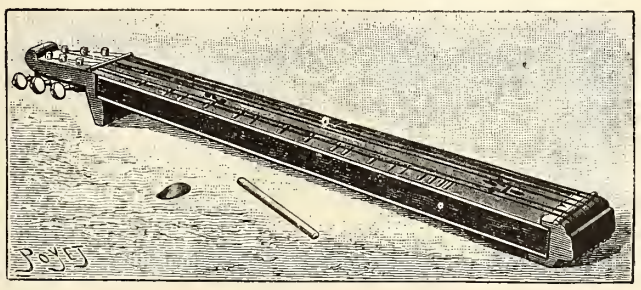


FIG. 2.—DETAILS OF THE INSTRUMENT.

IN blowing up Blossom Rock, San Francisco Bay, 43,000 pounds of explosives were used.

## THE GALLOPING DONKEY—A MECHANICAL TOY.

But few novelties in the line of mechanical toys made their appearance last New Year's. The little donkey drawing a cart on a full gallop comes to us from England. It was devised by Mr. Britain, of London, the inventor of certain other toys that we have already described.

The principle of the movement of the "galloping donkey," as it is called, is simple and interesting. The two forelegs of the animal are interdependent and are jointed to the body at their upper extremity. The same is the case with the hind legs. Moreover, the axis of articulation of these latter permits the donkey to oscillate slightly between the shafts of the cart. Two wire levers, each composed of two branches oscillating in two vertical planes in the vicinity of each other, are firmly connected with the two pairs of legs, with which they make an angle of nearly ninety degrees. Between the branches of these levers there oscillates a small cranked shaft jointed to the shafts of the cart. The latter carries, concealed beneath its platform, a heavy castiron fly wheel, which, being made to revolve by means of a string, communicates its motion through friction to the two wheels of the cart. Let us suppose that the latter is set in motion in the position shown in Fig. A of our engraving, where the four feet of the animal are seen in juxtaposition and the levers held in the air by the crank. The toy being placed upon the cover of a table (a cover is necessary to prevent sliding), the hind feet will bear upon it, and, in consequence of the movement of propulsion forward, the body of the donkey will oscillate around its axis of articulation and the forelegs, no longer finding any purchase upon the table, will rise. At the same time the hind lever will tilt and cause the descent of the cranked shaft, which will then reach the position B, and this motion will have lowered the front lever, which forces the forelegs to separate to their maximum extent. The front of the animal will fall back upon the table cover, where the forelegs will meet with a slight resistance. It is, therefore, around the articulation of the forelegs that the oscillatory motion of the body will occur. The front lever will rise to the position A, and so on. As a consequence of the combination of these two motions—the oscillation of the body of the animal and the rapid approach or recession of the legs by means of the levers—the inventor has succeeded in reproducing the motion of galloping with wonderful truthfulness.—*La Nature.*

## A PARIS ATTIC.

By Helen Evertson Smith.

Before landing in France most of us feel what seems to be a very reasonable degree of assurance that we who have read, and perhaps written, the French language ever since our early school days shall be able to speak it. But before we have been an hour on shore we find that we cannot even hear it understandingly, and rest in helpless bewilderment until some English-speaking porter or French-speaking friend comes to our assistance.

This much by way of explaining how I came to have some acquaintance with a Paris attic. Wishing to learn to speak the language as quickly as possible, I betook myself to a teachers' agency, established some twenty years ago, I believe, by an American. I asked for some one who would come to my lodgings to talk with me while I was dressing and eating my breakfast. Mlle. Estelle was a woman of "a certain age," short, plump, dark, bright-eyed, and vivacious, but with an almost touching sedateness of demeanor. The ridiculous sum charged for her services was two francs per hour, of which one-fourth was a commission to the agency. This seemed to me so small that I added another franc per hour, for which she immediately insisted upon giving me an extra hour whenever I had leisure to take it. After a while we compromised by arranging that she should give me from two to three hours daily, and take me about with her into places and scenes which to the average traveler remain unknown.

Mlle. Estelle, whose father and mother had been small shopkeepers, and died during the terrible siege, had inherited nothing but a good constitution, and a sturdy honesty and independence of character that always reminded me of the traits we ascribe to our Puritan ancestors. Her only sister entered a convent; but Estelle felt no "vocation," and began her life struggle entirely alone. She had received the sort of education usually to be obtained in the schools which the daughters of the poorer *bourgeoisie* attend. But from the first she appreciated its trifling character, and determined to improve upon it, supporting herself by the sale of fine embroideries while she studied hard and prepared herself for the examinations of the *Brevet Superieur*—a degree which admits the winner to teach in the highest schools. She passed this triumphantly, and then began what she regarded as the severest struggle of her life—the effort to obtain private pupils. She preferred this to accepting a position in a private school on account of the greater liberty enjoyed.

"I was not made, I, to be bound by other people's small rules of right and wrong. I believe in being good, yes, yes; but also I believe that I am just as good, just as worthy of respect, living alone in my little attic, where, when I shut my door, I may fling open the window, put out my head, and draw in the fresh air, and say: Here I am free! this is my own *chez moi.* It is poor, but no one has here a right to open my door without knocking."

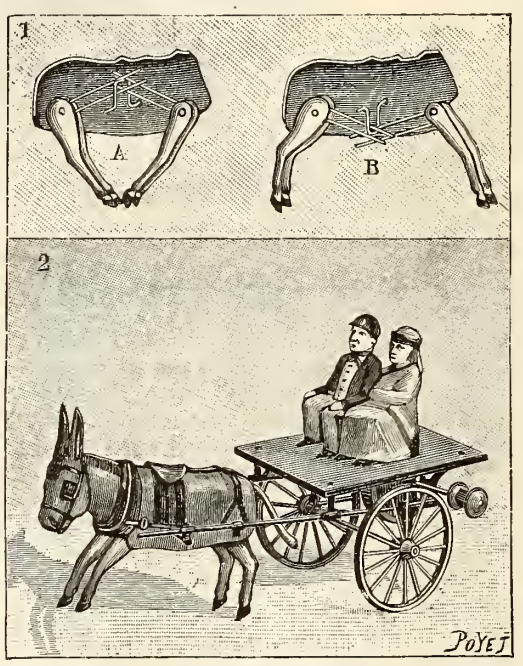
She must have had many a bitter struggle between her poverty and her purity, her native independence and the natural cravings of a strongly social nature; but she did not talk of them. A true-hearted woman, the difficulty surmounted had become but a step in her upward progress, for when I first knew her she conceived that she had attained a good measure of success. It was summer, and most of her pupils were out of town; but in the last winter she had had four music pupils, who each took two half-hour lessons a week, at one franc and a half (thirty cents). She had three boys to whom she taught Latin in class for one hour, five days in the week, at one-half franc for each pupil per hour; and two little girls to whom she gave two hours each day for one franc and a half for each pupil. And besides this, the teachers' agency had given her, for short periods, several Americans who had desired to study French. So that for six months she had averaged $11.10 a week. During the other six she was grateful for chance pupils like myself. I know that for two months she had no other.

Finding that I was curious about the way poor women live in the great city, which many deem to be the worst in the world, she took me to her own little abode. It was in a quite imposing-looking house on the unfashionable but sufficiently respectable Avenue Clichy. Before the door stood the fine equipage of some grand seigneur, who was calling upon a somewhat impoverished Bavarian nobleman who occupied the *premier.*

The *entresol* was occupied by an American family of respectability but small means. The second and third floors were tenanted respectively by the families of a French *rentier* (of moderate *rente*) and that of a violin master of high standing. The so-called *quatrieme* is actually the sixth floor, if one counts the *entresol* and the ground floor where is located on one side of the entrance a little *cremerie*, or milk and butter store, and on the other the tiny bureau of the *concierge*, or janitor. This *quatrieme* is divided into small rooms—those in the center, with skylights only, being devoted to the servants of the different apartments below, while those with dormer windows are rented to members of the laboring class.

This is a really delightfully democratic arrangement, for it gives to the poorest all the advantages of fresh air, good dwellings and respectable neighborhood, which are enjoyed by those who can pay more. It would be an immense blessing to the poor in our cities if it were so with us.

In this house there was no elevator, of course; they are only to be found in the new quarters of Paris, or in the most expensive houses. Even the front stairs were long and tedious; but they were comparatively easy to climb. Those by which the attics were reached were steep and tortuous. Water was brought no higher than the *troisieme*, so that those living on the top floor




THE GALLOPING DONKEY—A MECHANICAL TOY.

1, details of the mechanism; 2, general view of the toy.

had to carry it in pails up one flight of stairs; or, the concierge would do this for them, two large pailfuls daily for two sous a week. For the proper care and cleansing of the *cabinet* for the common use of all on this top floor, a weekly sou was paid to the concierge by each tenant. As the pipes could only be flushed by water carried up for the purpose, this was a matter of importance.

Arrived at Mlle. Estelle's room the door opens upon a scene of cheer and comfort. By a pocket tape measure I find that it is only ten feet by thirteen in size, and that the ceiling is only six feet and six inches from the floor over three-fourths of this space, sloping rapidly over the other fourth down to the very floor; but it is so light that it gives one the impression of being quite a spacious apartment. The window is five and one-half feet in width, and extends from the ceiling to within one foot of the floor. It, of course, has the French sash, opening like doors, but—what seems an advantage over most—each sash is divided into upper and lower doors, so that the bottom may be closed and the top open, or *vice versa.*

One cannot see the street from this window, because the broad gutters of the house, which run below it, project too far; but there is a grand breadth of sky, and some of the fine spires and domes of the gay city are visible, besides which one may see the attic windows of one's neighbors, and all of them, without exception, are like this of Mlle. Estelle, filled with growing flowers. "They cost nothing; we get the slips from each other, and once or twice a year the concierge fills our boxes with fresh earth, for which we pay him in new plants for his own boxes, which are so far from the sun light that his plants cannot flourish long and require to be renewed."

Mademoiselle's furnishings are very comfortable, having been purchased advantageously at second-hand. One of the tables is surrounded by a curtain; when drawn aside it discloses two shelves, on which are stored a little charcoal stove, a couple of bright copper saucepans, a coffee pot and a few dishes. On each side of the window hangs a cage containing a canary.

In this attic were five other rooms the size of this. One was occupied by a mother and daughter who made artificial flowers. By steady work for long hours they could only average about eight francs a day between them, yet theirs is skilled labor.

Another room was the abode of a very young and enthusiastic artist, whose income was not mentioned, possibly because there was none.

In another were two sisters, *couturieres*, one of whom went to the houses of her customers to do the cutting and fitting, the other staying at home and sewing busily. They had great pride in the recent acquisition of an American sewing machine, which it interested me to know had cost them only $25 to import, while my own of the same make and style had cost me $65 in America. By their united labor these sisters earned a weekly average, taking good and bad weeks together, of about $14.

On the fourth room were a man, wife, and child. The man was a worker in bronze; and because he was an artisan of considerable skill, he gained eight francs a day. His wife was a "mender;" that is, she earned sometimes as much as one franc a day, but often less, by mending the clothes of such of her husband's fellow-craftsmen as had no wives or mothers to mend for them. Their little boy, only six years old, had learned to net, and could earn a few sous each week by netting toy hammocks. He did not look upon this as work, but play; and his parents very rightly thought that he might as well turn his play to some profit. The money he gained was always put in a little basket as his own, and he was allowed (not, however, without some assistance in the way of advice) to decide in what manner it should be expended. He was now striving to lay up money to buy warm clothes for winter. I wished to help by dropping a few francs into the basket, but the mother promptly resisted, saying that "if madame wished to give *le petit Francois* a present of some little thing, it would be gratefully received, but not money. No! it was not well that little boys should think that money ever came without work."

The last room of the six was tenanted by a mother and her two young sons, fourteen and sixteen years of age. The double cot of the boys and the smaller one of the mother were separated by a neat curtain. The mother was *une femme sage*, whose practice was among the wives of the poor. She sometimes received fifteen francs and her board for a "case" of which she took charge for a week; but more often three francs a day for one, two or more days. When she had not work in this line she gladly took two francs for a day of extra work in families. Her two boys were apprenticed to furniture makers, and each received a franc daily, with a luncheon of bread and wine. These were the poorest tenants in the building, as Mlle. Estelle was the richest.

All of the little rooms were kept scrupulously clean, and, therefore, there was no suggestion of squalor. Neither was there any appearance of misery, degradation, or dissipation. The young artist sometimes sang a little when he chanced to come home late at night; but there seemed no reason to accuse him of anything more than a merry heart. The dressmakers and the flower makers sometimes made common cause and invited their friends to meet in one of their rooms, while all incommodious furnishings were carried into the other, thus making space for their guests, for whom, also, spare chairs might be borrowed from the rooms of the other tenants. For all refreshment there was nothing but *eau sucree*, which is surely the most insipid drink ever offered to mortals; but to judge by the laughter and song one might imagine it to be wine of a peculiarly exhilarating effect.

Occasionally—once in a month or so—the attic tenants would combine to purchase seats at one of the cheaper theaters, buying three seats for a party of six, and then taking turns in occupying them.

In looking at the circumstances of these attic dwellers, it is easy to see that gayety is a matter of temperament and not of external conditions. It is not, however, in the least due to a happy-go-lucky turn of mind. The French are essentially provident. The "long look ahead" is a strong characteristic, and to this is due the fact that they thrive and are happy where others would starve in misery. Their calculations are good, and all things are matters of calculation.

The rents in this attic of the Avenue Clichy were, for the rooms facing south, $1.60 per month; for those with northern exposure, $1.20; the difference being made up by extra fuel in the winter. Thus, instead of being the most formidable expense in life, the rent is proportionally the most moderate. Clothes are cheaper there than here; but not so much cheaper in the grades of goods worn by the working classes as is often imagined. As the latter do not try to follow (even at a long distance) the fashion of the rich, they are saved much useless expense. Mlle. Estelle owned but three dresses—a stout linen *peignoir*, for use in her own room only; a neat but somewhat worn black alpaca, for her daily visits to her pupils, and a new one for Sunday and *fetes.* There was a little variety in the matter of ribbons and ruffles; but otherwise all the women of the attic dressed in very nearly the same way.

Most foods are more costly in Paris than here, and, if the same wasteful methods prevailed there, an income of five francs a day—which, as will be noted, is a high average—would result in semi-starvation. French methods of household economy are worthy of special attention. Almost any French man or woman can cook, and they do not deem it beneath their dignity to do so. But fuel is dear, and the useful kerosene stove, though sometimes employed, is not popular. So their thrift and good sense have planned an escape.

Every few blocks in the poorer quarters one may see a modest sign of "*Cuisine Publique.*" Into one of these I went with Mlle. Estelle, and there we bought our breakfast—a bowl of a delicious and strong, hot soup, was two sous; an egg, poached or boiled, as desired, was two sous; about a foot in length of a long loaf of bread was two sous; and about half an ounce of butter was three sous; or, we could have a bowl of delicious *cafe au lait* for three sous. A bit of the beef from which the soup has been made, delicately flavored and served with mixed vegetables and a few spoonfuls of the thickened soup, was five sous. These were the prices if one chose to bring one's own dishes and carry away the food with one; or one could pay one sou more for plate and spoon or a fork and another for a napkin, and eat the modest breakfast on a long and beautifully clean counter. *Vin ordinaire* was always

to be had, and many took it, but not all; and I only once saw anything stronger taken. Other dishes can be had at proportionate rates. A really very good and nourishing meal may be had for six cents. The Parisian flower maker on her eighty cents a day can pay her rent, buy her clothes and food, and either lay aside a little for a rainy day, or help along some poorer relative, where one in this country with the same income, our rents, and our wasteful, improvident methods, would be half starved and wholly miserable.

It will be noted that these public kitchens are not charities. They are kept by persons who make a living by them. In summer they are chiefly patronized by women, who find it then more economical to buy their food cooked. In winter they are said to be filled by men, who have spent their summer elsewhere.—*The Independent.*

[Continued from SUPPLEMENT, No. 950, page 15186.]

## THE METHODS OF TESTING FATS AND OILS.*

By DR. ERNEST MAILLIAU, Director of the Government Testing Laboratory at Marseilles, France.

### SOLID ANIMAL FATS.

THESE are colored brown by a stream of chlorine gas.

*Butter.*—The analysis of this material, which has attracted so much attention during the last few years, is not so difficult as some imagine, but requires the skill of a practical and experienced analyst. The specific gravity of butter is notably lower than that of tallow and lard. It is the same with the iodin number and the freezing point of the neutral fat. The saponification and the solubility in absolute alcohol on the contrary are notably higher.

We can further confirm our results by microscopical examinations; melted butters showing under the microscope a collection of small regular spheres. Adulterated butter shows, on the contrary, abnormal figures, as well as crystals, which appear brilliant in the dark field of the polarizer.

By determining the fixed and volatile fatty acids, and the point of solubility in alcoholic toluene, a skilled analyst familiar with these processes can easily determine admixtures above 10 per cent. Below this point, I do not believe any adulteration would be profitable. Natural butter contains about 11 per cent. soluble and volatile fatty acids and 87 per cent. fixed fatty acids. Besides, alcoholic toluene dissolves it almost entirely.

*Tallow.*—The properties of tallow are so well known that they require no description. The distinction between beef and mutton tallow is a matter of interest and presents great difficulties from the chemical standpoint, and we can observe differences only by taking the melting and solidifying points of the neutral fat and those of the fatty acids.

*Lard.*—Lard adulterated with cottonseed oil is easily tested with nitrate of silver. If the lard has been altered by time or by other causes, it is necessary, before using this reagent upon the fatty acids, to take the precaution of purifying the fat in the manner in which I have indicated at the beginning of this lecture. We will thus avoid the slight reduction which is produced by decomposition products.

Some authors strongly believe in the use of the iodin number, which will give good results in the case of large admixtures, as well as for quantitative analysis of such a mixture. But it is quite illusory for the detection of a small proportion of cottonseed oil, for we must consider that the iodin number of pure lard varies within considerable limits, and it would be possible to correct for the high iodin number of cottonseed oil by the addition of tallow, which will lower it appreciably. In such a mixture the action of nitrate of silver on the fatty acids enables us to discover adulteration even below 5 per cent.

Tallow is detected by observing, under the microscope, the crystallization of the fat from ethereal solution.

### VARIOUS OILS.

The following oils, which frequently are used for the adulteration of agricultural fatty materials, are easily detected.

*Fish Oil.*—By its iodin number, its solubility in absolute alcohol, the presence of cholesterin, and finally the brown coloration by chlorin and red by caustic soda and phosphoric acid.

*Resins.*—By their density, their saturation, their solubility in absolute alcohol, and the deviation of the plane of polarization. Besides, it is easy to isolate them because the majority of compounds which they form with metallic salts are soluble in ether, while those of the fatty acids are insoluble.

*Resin Oils.*—By their property of not saponifying with caustic soda, by their insolubility in glacial acetic acid, and by the characteristic purple coloration which they give with fuming stannic chloride.

*Olein Oil of Commerce.*—By its solubility in alcohol and by its specific gravity.

Finally, the mineral oils, by their iodin numbers, their indifference to the action of caustic soda, and their insolubility in absolute alcohol at 15° C.

Gentlemen, we have nearly finished all we have to say in our lecture. The processes which we have just enumerated are applicable indiscriminately to fatty matters, both edible and industrial, for the determination of their purity, with an approximation sufficient for the majority of cases.

The results obtained will be more conclusive if they are compared with those from products of the same origin and known purity. Banish the thought that in this short discourse we have wished to indicate in an absolute manner those processes which must be used and those which should be rejected. We have desired only to explain the methods which have given us the best results in the thousands of analyses which we have had occasion to make on fatty materials, including 50,000 for olive oil alone.

Although most of the processes which I have just indicated were devised and perfected in our laboratory, and have been adopted by several governments, I have not, however, the presumption to feel that we have definitely finished this question. I consider, on the

* Read at a special meeting of the Chemical Section of the Franklin Institute, June, 1893.—*From the Journal.*

## A GENERAL COMPARATIVE TABLE FOR THE ANALYSIS OF FATTY MATTER.

| | Fatty Substance. | Density at 15° C | Action of Nitrous Vapors. | Sulfuric Saponification. Absolute. | Sulfuric Saponification. Relative. | Indices. Bromin. | Indices. Iodin. | Indices. Acetyl. | Freezing Points of Oils. | Fusing Points of Fatty Acids | Solidification of Fatty Acids. | Saturation by $Na_2O$. Number of Cubic Centimeters Normal Liquid Absorbed by Five grs. of Fatty Acid | Solubility in Absolute Alcohol. Number of Grams of Neutral Oil Dissolved by 1,000 Grams Alcohol. | Deviation of the Plane of Polarization. | Characteristic Properties. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Olive, | 0·915 to 0·917 | Solidification. Elaidin melts at 32° | 35° | 94° | 500 to 544 | 80 to 84 | 4·7 | + 1 to 4° | 27° | 23° | 17·86 | 43 | 0·6 Saccharimeter. | *Action of Nitrous Vapors.*—Operate by Calliete's process, pouring on twenty grams oil six grams $H_2SO_4$ and nine grams $HNO_3$. The characteristic colorations are first, with $H_2SO_4$ green, second, with $H_2SO_4 + HNO_3$ gray, third, after boiling straw-yellow, $H_2$ after cooling a hard mass, color of which is characteristic. |
| 2 | Peanut, | Unshelled, 917·5 Shelled, 921 | Liquid Mass. | 46° | 127° | 530 | 97 | 3·5 | — 1° | 31° | 28° | 17·89 | 66 | Variable. | Arachidic acid, $C_{20}H_{40}O_2$ (fusing point 75°), is characteristic and allows the detection of peanut oil containing 5 per cent. |
| 3 | Sesame, | 923 | " | 54° | 150° | 695 | 104 | 3·4 | — 5° | 26° | 22° | 17·70 | 11 | " | *Maillau's Process.*—The red coloration obtained by treating the rectified fatty acid of the oil with hydrochloric acid and cane sugar is characteristic. The fatty acid is first collected and melted in an oven. |
| 4 | Cotton-seed (edible), | 922 | " | 52° | 144° | 645 | 108 | 1·3 | — 12° | 36° to 37°·5 | 35° | 18·17 | 62 | " | *Maillau's Process.*—The black color obtained by the reduction of $AgNO_3$ in the presence of the saponified products of the rectified oil is characteristic. |
| 5 | Poppy (drying), | 925 | " | 8·0 | 222° | 835 | 133 | 13·1 | — 18° | 20°·5 | 16° | 18·13 | 45 | — 0·7° | Poppy oil when used as an adulterant of olive oil, prevents the solidification of the mass by the action of nitrous vapors. |
| 6 | Colza, | 914·5 | " | 48° | 133° | 640 | 99 | 6·3 | — 6°·5 | 17° | 16° | 16·49 | 20 | Variable. | A solution of potassium hydroxid heated with unpurified colza oil blackens with lead acetate, and reddens with potassium nitroferrocyanid. |
| 7 | Rape seed, | 915 | " | 56° | 155° | 632 | 103 | 5·9 | — 4° | 15°·5 | 14° | 16·68 | 15 | + 10° | Density and fusing points of the fatty acids |
| 8 | Linseed, | 932·5 | " | 121° | 336° | 1,000 | 156 | 8·7 | — 27°·5 | 23° | 21° | 17·98 | 70 | Inactive. | Density, freezing point, sulfuric saponification and iodin index, freezing points and fluidity of the fatty acid. |
| 9 | Walnut, | 926 | " | 99° | 275° | 737 | 144 | 7·3 | — 30° | Fluid | Fluid | 18·26 | 44 | " | Sulfuric saponification, iodin index, freezing points and fluidity of the fatty acid. |
| 10 | Cameline, | 926 | " | 51° | 141° | 817 | 132 | 7·5 | — 18° | " | " | 17·90 | 78 | — 3 | Iodin index, freezing point and fluidity of the fatty acid. |
| 11 | Beechnut, | 921 | " | 59° | 163° | 652 | 106 | 6·1 | — 18° | 24° | 17° | 18·18 | 15 | Almost Inactive. | *Brulle's Reagent.*—Two cubic centimeters nitric acid, 0·1 grams dried albumen, ten cubic centimeters oil; when agitated the mixture takes a characteristic vermilion tint |
| 12 | Mustard seed, | 918 | Soft Consistence Rather Firm. | 39° | 108° | 763 | 96 | 6·9 | — 5° to 0° | 16° | 15° | 17·97 | 28 | + 3 | Sulfuric saponification and iodin index. |
| 13 | Sweet almond, | 918·5 | " | 47·0 | 134·0 | 644 | 98 | 5·7 | — 10° | 14° | 13° | 18·22 | 39 | Almost Inactive. | Nitrous vapors and solidification of fatty acid. |
| 14 | Hazelnut, | 917 | " | 31·0 | 86·0 | 561 | 87·4 | 4·9 | — 21° | 23° | 20° | 17·63 | 33 | " | Sulfuric saponification and freezing points. |
| 15 | Castor, | 965 | Formation of Ricin-Elaidin | 40° | 111° | 559 | 84 | 15·3 | — 15° | 12° | 4° | 16·77 | Soluble. | Mean = 43 | Density, solubility in alcohol and crystallizable acetic acid, insolubility in petroleum ether, deviation of the plane of polarization. |
| 16 | Coprah, | 924·5 | Solidification. | 17°·5 | 48°·5 | 74 | 12 | — | Solid 22°·5 Fusion 26° | 26°·5 | 24° | | {Soluble at 31° C. in 2 vol. alcohol.} | Undetermined. | *Maillau's Process.*—The neutralized oil is soluble at 31° in twice its volume of absolute alcohol, and becomes insoluble on the addition of seed oils. Saturation, iodin index. |
| 17 | Cabbage palm, | 922 | " | 19° | 52°·7 | 99 | 16 | 23°·5 to 25°·5 | 23°·5 to 35° | 37° to 39° | 35° to 37° | | {Soluble at 31° C. in 4 vol alcohol.} | | *Maillau's Process.*—Like the preceding, but requires four volumes of absolute alcohol. |
| 18 | Palm, | 915 | " | 17° | 47° | 315 | 51 | — | 33° to 35° | 46° to 50° | 45° to 47° | | 400 | | Density, sulfuric saponification, partial solubility in absolute alcohol. |
| 19 | Mowrah, | 915 | " | 26° | 71° | 404 | 65·3 | — | 23° 27° | 46° 46° | 43° 5 | | 160 | | Density, saturation, when shaken with alcohol gives a characteristic milky tint. |
| 20 | Margarin from cotton-seed oil, | 920 | Soft Consistence. Solidification. | 47°·5 | 136° | 588 | 84 | — | 14° 26°·? | 46° 46° | 45° 5 | | 61 | | Iodin index, solidification of the oil; Maillau's Process (4). |
| 21 | Illipi, | 917·5 | " | 13°·5 | 37° | 152 | 24·7 | — | 28° 30° | 46° 46° | 45° 5 | | 260 | | Sulfuric saponification, iodin index, fusing point of the fatty acids. |
| 22 | Karite, | 917·7 | " | 28°·5 | 79° | 416 | 67·2 | — | 23° 25°·5 | 56°·5 | 52°·5 | | 80 | | Fusing point of the fatty acids, saturation, when agitated with alcohol gives a characteristic milky tint. |
| 23 | Butter, | 920 to 936 | Solidification. | 16° | 44° | 247 | 40 | — | 26 to 35 | — | — | 21·15 | Cod Liver, 240 | | Volatile fatty acids, iodin index, solidification of the neutral matter, saturation, microscopic examination. |
| 24 | Suet, | {Mutton, 917 Beef, 915} | " | 16° | 41° | 247 | 40 | — | — | — | — | 18·5 | Soluble. | | Sulfuric saponification, solidification of the fatty acids, insolubility in absolute alcohol. |
| 25 | Lard, | 920 | " | 33° | 91° | 365 | 59 | — | — | — | — | 18·25 | Almost Insoluble Cold. | | Sulfuric saponification, iodin index. |
| 26 | Fish oil, | 923 to 930 | Liquid Mass. | 5°0 to 100° | 136° to 277° | 761 to 872 | 123 to 141 | — | Congeals at 0° | — | — | 17·71 | Soluble. | Are colored brown by a current of chlorine. | Iodin index, solubility in alcohol (milky emulsion), fusion point of cholesterin. |
| 27 | Rosin, | 1·08 | Fluid Mass. | — | — | 718 | 116 | — | — | — | — | 15·13 | Almost Insoluble Cold. | | Density, saturation, solubility in alcohol, deviation of the plane of polarization. |
| 28 | Rosin oil, | 960 to 990 | Solidification. Elaidic Acid. Liquid. | — | — | 397 | 48 | — | — | — | — | — | Soluble. | | Density, deviation of the plane of polarization, insolubility in crystallizable acetic acid. |
| 29 | Commercial olein (oleic acid), | 900 | | 80 | 210 | 443 to 518 | 68·5 to 83·5 | 41 to 63 | + 4° to + 12° | — | 0° to + 8° | 17·7 | — | — | Density, nitrous vapors, solubility in alcohol. |
| 30 | Mineral oils, | 850 to 930 | | — | — | 80 | 13 | — | — | — | — | — | Insoluble Cold. | — | Density, iodin index, insolubility in alcohol. |

contrary, that in the vast unexplored region of the fatty series, we have only taken a few steps; but I feel at the same time that we are now in the possession of sensitive and scientific methods which permit us to detect mixtures, the determination of which has appeared impossible up to the last few years.

The mission with which I have been charged by the French and Tunisian governments in the interests of commerce and industry shows you to what extent these countries are desirous of facilitating the exportation of pure and satisfactory products. France furnishes the best growth of virgin olive oil, from Aix en Provence and Nice. Tunis also furnishes, but at a less price, olive oils of excellent quality, which we can certify without analysis, because the government imposes such heavy export and import duties upon seed and seed oils that it would be impossible to practice the smallest amount of sophistication.

Those who deal in olive oils often make the remark that pure oil is too strong and that it is improved in flavor by a mixture with seed oil. Without discussing this inexact statement, I believe that it would be preferable in every instance for the dealer to buy pure olive oil and to make his own mixtures. He would thus profit by the difference in price, which averages about 60 francs per 100 kilogrammes.

I hope you will pardon the dryness of the subject which we have just discussed, in considering how important it is for our two countries to have the same means of making analyses of American and French products. When we arrive at a complete understanding, discussions and reclamations will become impossible, and I cannot better conclude than by expressing the sincere wish that its realization will permit the two republics to bind more closely together their commercial relations.

## THE PROBLEMS OF LIGHTING.

Every body emits luminous radiations and different colors, according as it is heated to a greater or less degree. At a slightly elevated temperature, red radiations prevail. At high temperatures, violet and ultra-violet radiations are added. The brilliancy of an incandescent body more closely approaches that of the sun in measure as the relative proportions of its various radiations more closely approach the composition of the solar spectrum. Then it appears white.

It is the predominance of each simple color in the spectrum emitted by our different domestic lights that explains their respective coloration—the reddish tint of the Carcel lamp, the violet tint of the voltaic arc, the greenish tint of the kerosene lamp, etc.

Each of these illuminants has its drawbacks and its advantages, for each of the colors influences our eye diversely and specifically.

Lights rich in violet and ultra-violet rays, like those of magnesium and the voltaic arc, are certainly very harmful to the sight. It is such rays that in the solar light cause the erythema commonly called sunstroke. Moreover, such radiations, called also chemical or photographic, must hasten the destruction of the fibers of the crystalline lens, whose curves, which are variable under the action of the ciliary muscle, permit us to see objects distinctly at different distances. In fact, the crystalline lens absorbs such radiations, which are in great part invisible, and converts them into visible ones. It is phosphorescent. All those who have worked by such lights have, in the long run, experienced a painful fatigue in the muscles of the eye.

The sources very rich in greenish yellow radiations have the inconvenience of destroying to a greater degree than the others a photographic substance of the retina called erythropsine, which is not indispensable to vision, since it does not exist where the latter is most distinct, that is in the central spot; but the destruction of this substance by light corresponds to a great fatigue of the nerve, just as its regeneration in darkness coincides with the restoration of the visual power.

The visual functions are complex. We preceive light, we distinguish color, and we draw the perception of forms from differences in light. If we desire to have a perception of a luminous spot with a minimum of colored light, such spot must be bluish green. It is such radiations that are the first to appear when a metal is heated—at 417° with gold, 390° with platinum, and 377° with iron. Bluish green excites the luminous sensitiveness. When it is desired to protect the eye against too bright a light, there is every interest, then, in adopting a bluish green glass rather than one simply smoked. The patient gains force therein for his luminous sensitiveness.

If we desire to perceive objects very distinctly, we must adopt a source of a yellow color. Every one knows that yellow is more luminous than green or red; but how much? This problem of the luminosity of the spectrum is one of those that have most exercised the sagacity of physicists and physiologists. It has as yet been but approximately solved, and with the aid of artifices. This difficulty is due to the fact that our sensitiveness behaves in a special manner for each color under identical conditions of variations in luminous intensity. For example, put a red and a blue glass in a lantern, and increase the intensity of the illuminant, and the red glass will appear to have gained more light than the blue one. The illusion will disappear if, in winking the eye, one diaphragms the retina sufficiently to reduce the images of the two glasses to an extreme smallness. The color phenomena disappears, and we no longer compare anything but grays. It is by this method, among others, that one has succeeded in seeing and measuring the different illuminating powers of colors.

Let us take a red and a blue light. We can compare them with each other in seeking the distances at which each of them will permit us to read our newspaper and may admit that they are equal when they allow us to read with the same distinctness, or, as it is said, when the visual acutenesses are equal. The variations in visual acuteness for the different portions of the spectrum have been compared with the variations in brightness. The laws are not the same. The maxima are indeed nearly in the same place in the yellow, but the brilliancy decreases much more quickly than the visual acuteness in the red. The practical consequence is that if one can employ a little more light, and desires to make characters and forms distinguishable, he will adopt a red lantern rather than a yellow one. It is doubtless to its reddish tint that the old Carcel lamp owes the persistent favor in which it is held by old studious readers.

The ideal source of light is that which would emit neither calorific radiations, which are sometimes so fatiguing in gas burners, nor obscure radiations, which are totally useless and often injurious when they favor the oxidation of the coloring matter of tapestries, etc. Take the energy of the luminous radiations on the one hand and the energy of the totality of the radiations on the other, and divide these quantities one by the other and we shall have what is called the optical rendering of a luminous source.

One of the quickest methods of measuring such rendering consists in making the radiations first traverse a stratum of sulphide of carbon, which allows them all to pass, and then an equally thick stratum of a solution of alum, which allows only the luminous radiations to pass, and in measuring the intensities in both cases with the thermo-electric pile. The oil lamp has but 3 luminous radiations out of 100, the ordinary gas burner 4, incandescent electric lamps a mean of 6, arc lamps a mean of 12, the magnesium light 15, and the Geissler tube, which is not a practical source, presents an optical rendering of about 32 per cent.

It has recently been found possible to improve the optical rendering of gas by raising to incandescence a small trellis dipped in a solution of a mixture of calcined earthy oxides (zircon and oxides of lanthanium, yttrium, thorium, corium and neodymium) and suspended by a metallic arm above a Bunsen burner. It may be asserted, however, that the optical rendering of our usual sources does not exceed 6 per cent., and that the advantage accrues to electricity.

The last word has not been uttered, it is unnecessary to say. In electric lamps, as well as in the ordinary gas burner, it is the incandescence of the carbon that gives the light. The law of incandescence of magnesium seems to be wholly different and much more favorable to high optical renderings. It is in such directions that researches should be prosecuted.

The results appear to be less brilliant still when we take into account the special conditions of production of the electric current. The rendering of a steam motor is scarcely more than 10 per cent., while that of a dynamo machine is 90 per cent. There is a loss of about 10 per cent. in the conductors, so that the final optical rendering of the energy absorbed in an electric lamp is about 1 per cent.

Nature has solved the problem in a much more brilliant manner, but not practical for our needs, in the organic substances and organized bodies called phosphorescent.

A phosphorescent body absorbs the more or less invisible ultra-violet radiations of the spectrum, and converts them into violet, green, yellow, or orange radiations without any disengagement of heat. It emits only visible radiations, many at first, and then fewer and fewer down to zero, with a rapidity that varies according to the substance.

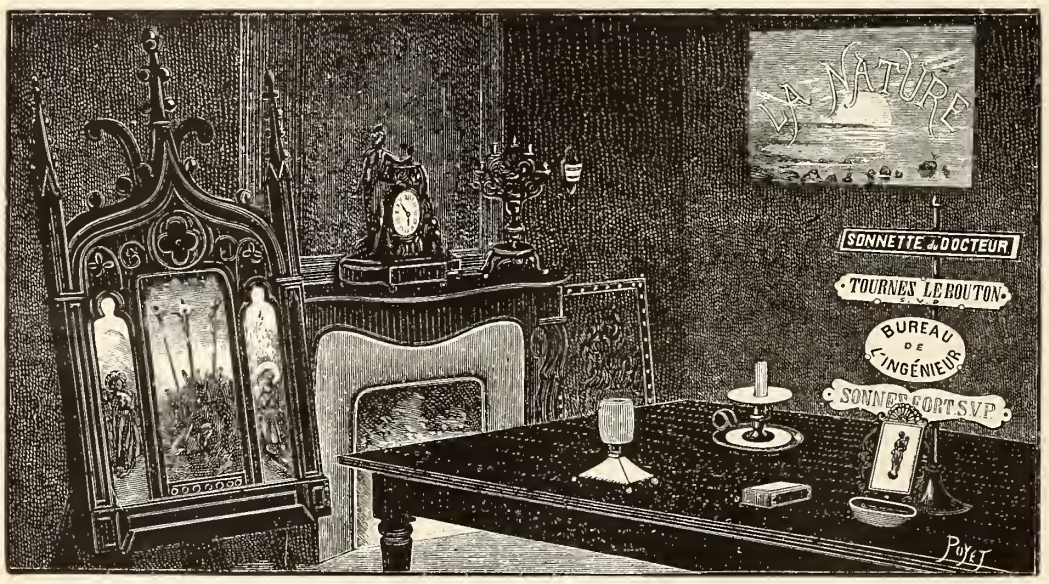
A large number of substances are phosphorescent, but their phosphorescence often lasts less than a second, and can be observed only with special apparatus.

The substances that retain their light the longest are the alkalino-terreous sulphides: The sulphide of barium, discovered accidentally in 1602 by a shoemaker of Bologna (Vicenzo Casciorolo), and the sulphide of calcium, strontium and zinc, all prepared in a more or less paradoxical and always empirical manner.

This chapter of physico-chemistry is still full of obscurities. For example, we cannot give sulphide of barium a blue or violet light, but we can give different colors to sulphide of calcium according to the nature of the lime that has served to prepare it. Its phosphorescence is yellow with limestone, green with aragonite, and violet with fibrous aragonite. These various colors seem to be due to different impurities, yellow to the presence of peroxide of manganese, blue to the presence of persulphide of potassium, and violet to traces of bismuth. In another case, in my preparation of phosphorescent sulphide of zinc, the phosphorescence seems to be due to the purity of the body.

The industries have utilized the sulphides of calcium in pocket match boxes, placards, watch dials, etc., that some years ago awakened curiosity. These sulphides are very alterable in the air, water, etc., and have to be covered with an enamel, but, as the latter scales off quite quickly, they lose their phosphorescence pretty rapidly.

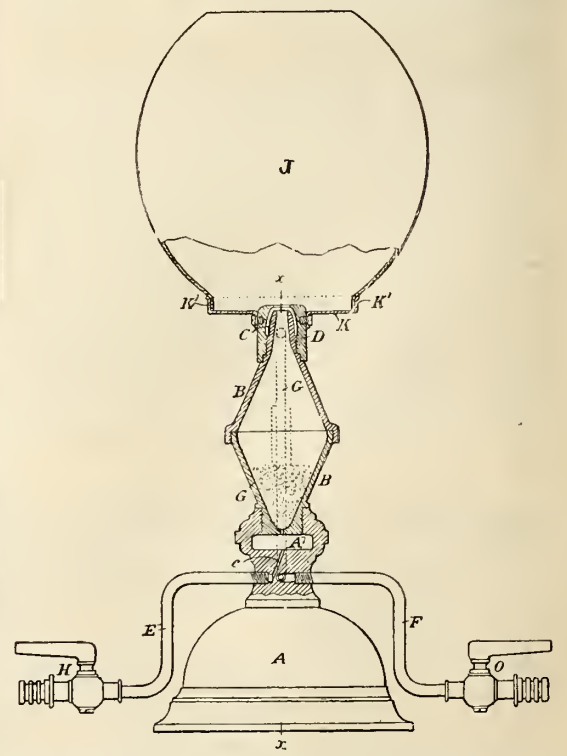
The duration of the luminous emission of well prepared sulphides of calcium is quite lengthy. They still shine notably at the end of a six hours' stay in darkness. The phosphorescent sulphide of zinc is scarcely visible practically for more than two hours. This is to be regretted, since this body is remarkably unalterable in the air, water, and ammoniacal or acid vapors, etc. It lends itself wonderfully to the role of a storer-up of light. Hereafter, one might study an arrangement to permit of storing up the light of the sun upon vast surfaces, preserving it till night and concentrating it in a source by means of lenses. This would be light for nothing, at least theoretically, for the interest on the cost of the installation would render it very expensive, even if it could be intensified sufficiently to be practical. Such a source of light would evidently have a maximum optical rendering. This is also the case with the light emitted by glow-worms under the influence of the nervous system and composed almost solely of yellow and green radiations; and such is the case with the infusoria that produce the phosphorescence of the sea, and with the microbes that make the glaciers of Norway gleam.—*C. Henry, in La Nature.*




LUMINOUS OBJECTS MADE OF PHOSPHORESCENT SUBSTANCES.

## A MAGNESIUM LIGHT.

This invention, by W. Willis and E. J. Humphery, of London, and W. H. Smith, Surrey, Eng., relates to the production of light of great actinic power for photographic and other purposes, by burning magnesium, aluminum, or other substances in a flame of hydrogen or other inflammable gas.




The burner consists of two concentric tubes, C, D. B is the receptacle for the powdered magnesium. The inflammable gas enters through E and *e*, and passes up through the powdered magnesium, carrying some of it with it in suspension to the inner tube of the burner, C. At the orifice it meets with oxygen supplied to the outer tube, D, through F, and on being ignited the gas and magnesium powder burn. The lamp, fitted with a lens and chimney and applied as a "search light," is described.

## THE GREEN COLORATION IN OYSTERS.

By Ad. Chaten and A. Muntz.

This question is at once chemical and biological. The investigation has been committed to a M. Berthelot (probably a son of the M. Berthelot of the Academy of Sciences). It is shown that the green color of oysters has no relation with the chlorophyl of plants, or with other known coloring matters, animal or vegetable. He shows also that oysters contain iron, and that the mud of the oyster beds contains iron sulphide, to which its black color is owing. Both the coloring matter and the iron are especially accumulated in the gills of the oysters, while the rest of the body is nearly colorless. The composition of the green pigment has not been determined.

## THE BEAR'S PAW FERN.

AMONG the deservedly popular, as also among the many ferns which by their quaintness as much as by their beauty attract the attention of the lover of nature, this most singular plant justly holds a very prominent place.

It is known in collections under the various appellations of Aglaomorpha Meyeniana, Drynaria Meyeniana, and Drynaria philippinensis; whereas in books of purely scientific character it is found described as Polypodium Meyenianum. The sub-genus Drynaria,

THE BEAR'S PAW FERN.
(*Aglaomorpha Meyeniana.*)

to which it undoubtedly belongs, forms a small division of the most extensive of genera, Polypodium. It was originally founded by Bory, and comprises only a few, barely a dozen, known species of ferns, which are distinguished from ordinary Polypodiums by having either a separate fertile frond or its ordinary one fertile at its summit and deeply cleft at its base, like a stalkless oak leaf, brownish in color and rigid in texture. Schott gave the name of Aglaomorpha to the bear's paw fern, and to this day it is under that expressive name that it is best known.

The bear's paw fern is possessed of a quite attractive character; the rhizomes with which it is provided are of a particularly stout nature and densely clothed with narrow, crisped scales half an inch long, of a bright rusty brown color, and of a particularly soft nature. From these singular-looking organs, as thick as a man's wrist, and to which the plant owes its popular appellation, the fronds are abundantly produced. When the plant is fully developed and in good condition, these are frequently 2½ feet to 3 feet long, and 8 inches to 12 inches broad. As may be seen by the accompanying illustration, their lower portion, which is always barren, is cut nearly to the midrib into oblong entire lobes, while their upper part, which usually extends about one-third of their length, bears the fructification, which hangs out so prominently as to give the plant quite the appearance of what is commonly called a "flowering fern." This fertile portion consists of closely set narrow leaflets, each 4 inches to 6 inches long, having all the appearance of a firm midrib, with a row of small round lobes on both sides, each bearing a bright yellow spore mass, by which it is eventually entirely covered.

The bear's paw fern, which is as pretty and ornamental as it is distinct, is a native of the Philippine Islands, where, according to numerous travelers, it grows abundantly on branches of trees. This circumstance is quite sufficient to explain the difficulty which one usually experiences in growing it in a pot. It thrives apace under artificial cultivation when subjected to treatment similar to that given to Platyceriums, or stag's horn ferns. It should be planted either on a stump of partly decayed wood or on cork bark in a shallow pan or in a hanging basket, in pure fibrous peat, on which its rhizomes, which must never be buried, should at first be pegged down, free scope being allowed for their extension. As will be seen from the above description, every part of this singular plant is possessed of special interest, and when properly grown it well repays for any extra attention given to its requirements. It may be propagated from spores, but this is a long and tedious process, and it is usually increased by the division of the rhizomes, an operation which is best performed from January to April.—*The Garden.*

## AN ARBOREAL JUNK.

WE are indebted to the kindness of Mr. J. H. Veitch, whose account of his travels in China, Japan, the Corea, India, have appeared during the last year, in enabling us to afford our readers a figure of a remarkable specimen of tree training. He says: "The pine figured is one of the most curious of the many interesting and strangely trained pines in the whole empire of Japan. In the Chinese garden (laid out between four and five centuries ago), attached to the Kinkakuji monastery of the Zen sect of Buddhists in Kzoto, this remarkable example of horticultural art stands alone in a court yard, the result—according to the attendant priests—of over three centuries of patient labor. Trained as a sailing junk, the main trunk forms the mast; and two branches springing from the stem at right angles, and but a few inches from the ground, form the basis from which the whole upper structure of the hull has been drawn. The hull is thirty-five feet in length, and somewhat exceeds the height of the whole tree. The remaining branches on the main trunk are bare of foliage from 12 to 18 inches from their base, the foliage being confined to the distal part of the branches, the branchlets of which have been trained in continuous winding circles, so that the leaves and young shoots now rest on thick layers of twisted, interlaced, stiffened wood, the accumulated training of many scores of years."—*The Gardeners' Chronicle.*

JAPANESE PINE TREE TRAINED IN THE FORM OF A SAILING JUNK.

## DRACÆNA THALIOIDES.

THIS distinct species of Dracæna, now in flower at the Royal Gardens, Kew, was discovered on the Gaboon, in West Tropical Africa, by Gustav Mann, and introduced into cultivation about thirty years ago by M. Aubry-le-Comte, who sent it to the Jardin des Plantes, Paris, where it was named D. Aubryana by Brongniart. About the same time it was sent out by Messrs. Makoy & Co., of Liege, as *D. thalioides*, under which name it was figured by Morren in *Belgique Hor-*

DRACÆNA THALIOIDES.

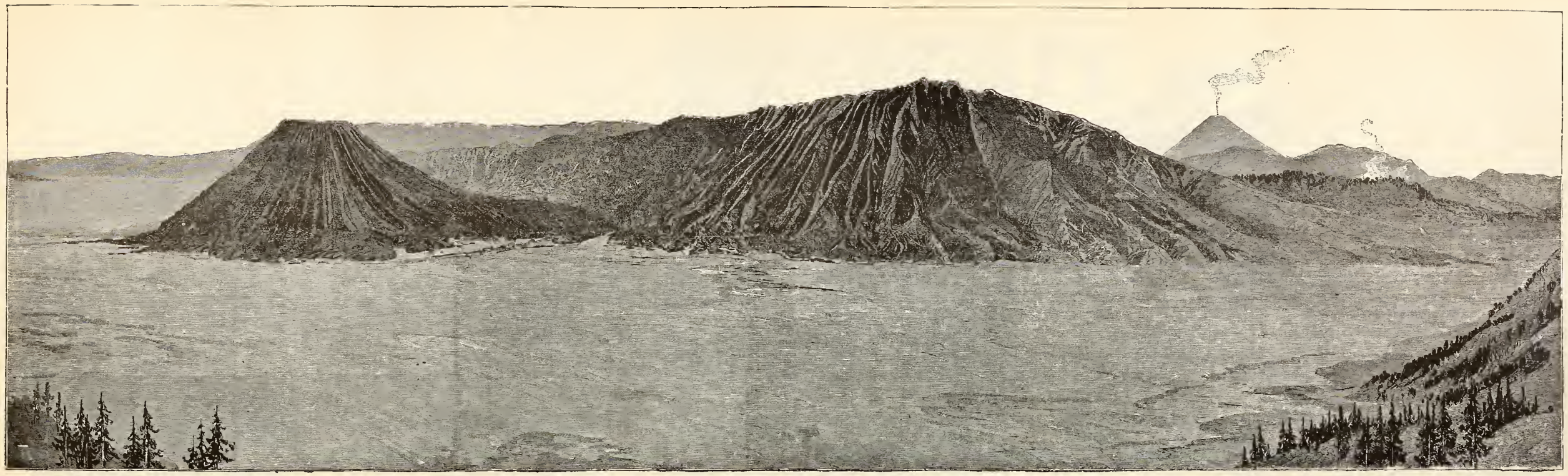
*ticole*, 1860, p. 348. Mr. Baker keeps up Morren's name in his revision of *Asparagaceæ* in vol. xiv. of the *Linnean Journal*, p. 534. There are living plants of *D. thalioides* at Kew, where it grows about a yard high, with leaves nearly a yard long, the lower half being narrow and petiole-like, the upper half a flat lanceolate blade 2½ inches wide. It flowers annually, producing an erect stout spike of whitish flowers, which are arranged in crowded fascicles and open in successive batches. The special interest attached to this plant just now lies in the fact of its having been confused with *D. Sanderiana*, which was conjectured to be a variegated variety of *D. thalioides*. A comparison of the figure herewith given with that of *D. Sanderiana* in our volume xiii. of last year, p. 442, Fig. 65, will at once prove that these two plants are widely distinct from each other. *D. thalioides* is a handsome green-leaved stove plant of easy cultivation, throwing up suckers freely and flowering annually when strong. It is, of course, a true *Dracæna* of the same set as *D. Goldieana*, and only distantly related to *D. terminalis* of gardens and its varieties, which properly belong to the genus *Cordyline*. For the opportunity of figuring the plant we are indebted to the director of the Royal Gardens.—*The Gardeners' Chronicle.*

## EARTH MOVEMENTS.*

EVERY year, every day, and possibly every hour, the physicist and observer of nature discovers something which attracts attention, causes wonder, and affords material for discussion. At one moment we are invited to see solidified air, at another to listen to telephonic messages that are being transmitted without a wire, or to pause with astonishment before a pen which is producing a fac-simile of the writing, the sketches and the erasures of a person who may be in a distant city. Not a day passes without a new creation or discovery, and novelties for our edification and instruction are brought to our notice at the meetings of societies and conventions which from time to time are held in various parts of the world. At the last meeting of the British Association, held in Nottingham, the attention of members was called to the reports of two committees summarizing a series of facts which seem destined to open a new field in the science which treats of movements in the crust of our earth. For thirteen years one of these committees has devoted its attention to the volcanic and seismic phenomena of Japan, with the result that our knowledge of these subjects has been considerably extended. Now we observe that earthquakes, which are referred to as catastrophes in the processes of mountain formation and the elevation or depression along our coast lines, are spoken of as "vulgar disturbances" which interfere with the observation of certain earth movements which are probably as common to England as they are to Japan.

Earthquake observations, although still capable of yielding much that is new, are for the present relegated to a subordinate position, while the study of a tide-like movement of the surface of our earth, which has been observed in Germany and Japan, earth

* From *Nature.*



The Great Sand Sea. Smeroe, an active volcano and the highest mountain in Java (12,300 feet above sea level). Bromo, an active volcano

## THE GREAT SAND SEA OF THE TENGE MOUNTAINS, JAVA.

tremors, and a variety of other movements, which we are assured are continually happening beneath our feet, are to take their place. Only in a few countries do earthquakes occur with sufficient frequency to make them worthy of serious attention. The new movements to which we are introduced are occurring at all times and in all countries, and we are asked to picture our continents as surfaces with a configuration that is always changing. We are told that every twenty-four hours the ground on which we live is gently tilted, so that the buildings in our cities, and the tall chimneys in our manufacturing towns, are slightly inclined like stalks of corn bent over by a steady breeze. The greatest tilting takes place during the night; in the morning all return to the vertical.

Why such a movement should exist, we are not told. All that we hear is that it is too large for a terrain tide produced by lunar attraction. In Japan it appears possible that it may prove to be a concertina-like opening and shutting of the crumpled strata forming a range of mountains. To determine whether this intermittent puckering of strata, which would mean a daily increase and decrease in the height of mountains, explains the variability in the level of districts where observations have been made, is a matter for future investigation.

A problem which suggests itself in connection with this novel work will be to determine the limiting change in inclination, which we will assume means rock-bending, that culminates in sudden fracture and a jar, causing an earthquake.

Earthquake prophets up to the present appear to have lived upon the reputation of a few correct guesses, the non-occurrence of which would have been contrary to the laws of chance. As observation has shown us that a very large proportion of our earthquakes, like those which occur in the Himalayas and the Alps, and even those which occur in volcanic Japan, are produced by faulting or sudden breakages in crumpling strata, rather than by explosions at volcanic foci, it would seem that a study of the bending which leads to fracture would be a legitimate method to approach the vexed question of earthquake prediction.

Another class of movements to which our attention is called are our old acquaintances, the microseismic or tremor storms, which are now defined as long, flat waves which give to the surface of our earth a movement not unlike the swell we so often see upon an ocean. Such disturbances are particularly noticeable whenever a district is crossed by a steep barometrical gradient. It is not unlikely that these movements, which are appreciable at considerable depths, have an effect upon the escape of fire damp at our collieries, that may influence the accuracy of delicate weighing operations—as, for example, during the determination of standard weights—that they may interfere with gravitational observations and that they are a neglected source of error in certain classes of astronomical work. Our attention is next directed to the bending effect produced in certain districts by the rise and fall of the barometer, certain areas under variations in atmospheric pressure behaving as if they were the vacuum chambers of an aneroid.

Then there are the earthquakes of comparatively restful countries like our own. A large fault by which mountains are suddenly lowered and valleys compressed takes place in a distant country like Japan. Near the origin of the dislocation the shaking brings down forests from the mountain sides, and the neighboring district is devastated. As the waves spread they become less and less violent until, after radiating a few hundred miles, they are no longer appreciable to our senses. But the earthquake has not ended. As long, flat, easy undulations it continues on until it has spread over the whole surface of our globe. The waves passing under Asia and Europe reach England first, while those crossing the meridian of our antipodes and North America arrive somewhat later. At Potsdam, Wilhelmshaven and in Japan, waves of this order have often been recorded, but for the rest of the world they are thus far unrecognized. Great cities like London and New York are often rocked gently to and fro; but these world-wide movements, which may be utilized in connection with the determination of physical constants relating to the rigidity of our planet's crust, because they are so gentle, have escaped attention.

That the earth is breathing, that the tall buildings upon its surface are continually being moved to and fro, like the masts of ships upon an ocean, are at present facts which have received but little recognition. Spasmodic movements which ruin cities attract attention for the moment, but when the dead are buried and the survivors have rebuilt their homes, all is soon forgotten. It seems desirable that more should be done to advance our knowledge of the exact nature of all earth movements, by establishing seismological observatories, or at least preventing those in existence from sinking to decay. J. MILNE.

## THE GREAT SAND SEA OF JAVA.

ONE of the most extraordinary valleys in the world is the Valley of Death, in Java, in which there is not a sign of vegetation, and which is often fatal to animal life. It is said that nothing can cross it alive, and that animals which wander into it drop down dead after a few minutes. The explanation of this is that carbonic acid gas is exhaled from the ground of this volcanic region, and that the gas, being heavier than air, lies in the hollows of the valley and stifles anything that tries to pass through it. The great Sand Sea of the Tenge Mountain in East Java is the crater of a huge extinct volcano, about six thousand feet above the level of the sea. It is two miles long by a mile and a quarter broad. The island of Java has, with some justice, been called "The Lid of Hell," and the title is not altogether inappropriate, as there are some thirty volcanoes in the island, and the country owes its fertility to the volcanic nature of the soil. With the exception of the wild volcanic mountains, the scenery of Java is rather disappointing, flat fields of rice properly leveled and embanked, stretching away on all sides in the low lands.—*The Graphic, London.*

[FROM NATURE.]

## THE PLEIADES.

AMONG the many constellations and star clusters which attracted the attention of our early ancestors, few, indeed, were so constantly observed as that small bunch of twinkling brilliants known as the "Pleiades." From a very early date, when our forefathers were not so well acquainted with the divisions of the year as we are to-day, they needed some means by which they could tell when to sow their corn and make arrangements for other agricultural pursuits which could only be done properly in their right seasons. That they could, at any rate, get a rough approximation of such divisions of the year by means of the positions of the heavenly bodies, they soon found out, and they were thus led to observe sometimes stars, sometimes groups of stars, near the rising or setting of the sun, and even certain stars, or groups of stars, at their times of rising and setting.

That they should have chosen that group of sparkling stars, the Pleiades, to serve their purpose, does not seem at all as astonishing if one considers how easily they can be recognized in the sky, and also their important position in more remote times.

The different relative positions of the sun and the Pleiades had, no doubt, first attracted special attention to this group of stars, and we know how important a *rôle* they played in ancient times for calendar purposes.

Let us just consider the several positions of the Pleiades as a result of the earth's rotation and revolution round the sun. Commencing about the end of May, we find that the Pleiades are altogether invisible, as they rise and set together with the sun. As time goes on, they will appear above the horizon before the sun, the difference in the time of rising of these two objects gradually increasing. In August the Pleiades cross the meridian about the time the sun rises, and by the end of November they are visible throughout the whole night, their upper culmination taking place at the same time as the lower culmination of the sun. As November draws to a conclusion, they set earlier and

earlier, and by the end of February are visible only for a short time, disappearing altogether for a time after the middle of May.

Owing, however, to a slight movement of the axis of the earth, which makes a revolution round the pole of the ecliptic once in about 25,800 years, the point of intersection of the ecliptic with the equator is not fixed, but movable; thus we can understand that the positions of all heavenly bodies as regards their right ascensions and declinations suffer a continual but slow alteration.

This slow movement explains the reason why the Pleiades have not always been invisible at the end of the month of May, and we have only to form a simple calculation to become acquainted with the fact that about two thousand years ago this period of invisibility occurred nearly a month earlier.

A very interesting point relating to the Pleiades is the great number of different names which have been applied to them, and also the curious myths which have arisen from time to time. A most interesting account of these has recently been published by M. Richard Andree,* who has brought together a mass of matter relating to both names and myths. First, with regard to the names which were used when referring to the cluster. The general words defined them as a heap, troop, host of dancers, sieve, etc.; sometimes the simple word "many" was adopted. One finds them spoken of as herds, or hosts of animals, birds, such as hen with chickens, parrots, doves, etc. The simplest expressions really used meant "mass," and an examination of the records confirms this view.

In observing the Pleiades any one would remark how closely they are packed together. This closeness led early peoples, no doubt, to refer to them as a host or herd of animals, and hence the well known name, "the hen with her chickens."

Among many foreign names for this, we have in German, Der Glucke mit ihren Kuchlein; in Danish, aftenhone (evening hens); in French, la poussiniere; in Italian, gallinette, etc. Instead of a host of animals, we have a host of people referred to, such as, for instance, in the Solomon Islands, where they are called "togo ni samu," meaning a company of maidens. The North American Indians have also known them under the name of "dancers."

It may be thought that a natural name by which they would be known would give some idea of the number of stars in the group; this was often the case, only with different names, for a very good pair of eyes could distinguish seven stars, while generally only six were counted. The word for the Pleiades, for instance, in old high German was "thaz sibunstirri" (seven stars), while that of the South Americans, "cajupal," meant six stars. Again, in Cook's Islands the word "Tau-ono" (six) was used, while the Greeks had a special name for *each* of the seven stars.

Seeing that so much importance has been attached to the Pleiades by peoples of all countries, it is natural to find that the number of myths is by no means few; this is shown to be the case by examining the records of the ancient Greeks, the peoples from East Asia, South Sea Islands, America, etc.

To describe a few briefly, let us refer first to that which we owe to the Greeks. The Pleiades in this myth were the daughters of Atlas and Pleione, each one of which bore a separate name. The Hyades, for sorrow at the death of their sisters, or, as others say, at the destiny of their father, Atlas, killed themselves and became fixed as a constellation in the heavens. Another myth, by Pindar, describes them as the comrades of Artemis, who were turned into doves, and eventually into stars.

A myth of much interest is that of the Dyaks, and the Malays of Borneo. They say the Pleiades were six chickens followed by their mother, who remained always invisible. At one time there were seven chickens in all. One chicken paid a visit to the earth, and there received something to eat, at which the hen got so angry as to threaten to destroy both the chicken and the people on the earth. Fortunately the latter were saved by the constellation of Orion, leaving only six chickens in the brood. At that period of the year when the Pleiades are invisible, the Dyaks say that the hen broods her chickens, while at the time of visibility "the cuckoo calls."

The South Sea islanders have a myth which has some originality about it. It is to the effect that the Pleiades were originally a single star, which shone with such a clear luster as to incur the envy of the god Tane, who was in league with the stars Aldebaran and Sirius, and followed the Pleiades. Trying to save himself in a stream, the course of which Sirius had so diverted as to bring him close to Tane again, he was broken up into six bright stars by Tane himself, who hurled Aldebaran at him.

The blacks of Victoria, Australia, have a myth in which the Pleiades are considered a host of young wives who play with the young men. The myth of the Kamilaroi blacks is as follows: The Pleiades were once pretty maidens on the earth, who were followed by some young men called the Beriberi. To get away from the latter the girls climbed trees, and thence sprang into the heavens, where they were transformed into shining bodies; one maiden who remained behind was termed "gurri gurri," the shy one, and she is represented by the least bright star in the group. The Beriberi were eventually placed in the heavens, where they appear in the girtle and boomerang in the constellation of Orion.

These and many other myths, all of great interest, are mentioned by M. Andree. They inform us to a certain extent of the characters of the different nations. Much might be learned also about the origin of the various tribes of people, by seeing if the different myths can be traced back to an initial one. Those of the North American tribes, for instance, seem to have a common origin. In some instances the Pleiades were undoubtedly looked upon as a god who, besides regulating the year and looking after the fruitfulness, was the ruler of all meteorological and astronomical appearances. Hesiod refers to the rising of the Pleiades as the time for harvest, while the period about which they disappeared for some time he termed plowing time. Forty days and nights were they invisible, appearing again only as soon as the sickle was sharp. Another very well known use made of the visibility and invisibility of the Pleiades was the regulation of the traffic of ships in Greece, hence probably the Greek word for to sail, $\pi\lambda\epsilon\epsilon\iota\nu$. The rising of this group of stars was the commencement, so to speak, of the shipping season, their disappearance denoting its conclusion. At Rome, also, the same practice was in vogue.

Enough has been said to attract the reader's attention to some of the numerous interesting references about this group of stars. The nineteenth century has already seen the end of many a myth which has been solidly upheld; but as science advances, facts take the place of myths, and although much of the romance may appear to be lost, one always looks back at them with delight. Few stars, perhaps, have been so shrouded in myth as the Pleiades, and the unravelment of these myths has been the source of pleasure to many.

* See *Globus*, Bd. lxiv., No. 22, "Die Plejaden im Mythus und in ihrer Beziehung zum Jahresbeginn und Landbau."

## LONGEVITY, WITH A LIST OF PERSONS KNOWN TO HAVE LIVED ONE HUNDRED YEARS OR MORE.*

By ARCHER ATKINSON, M.D., of Baltimore, Md.

To know how to attain longevity with a full amount of mental vigor and bodily health should form the *summum bonum* of mankind. To know how to prolong life and yet enjoy it is to reach the acme of all our diseases, and a knowledge of those measures which tend to prolong life healthfully should constitute the desideratum of the best of men. In spite of every effort, many die early. The poet says "the good die first;" but it is questionable whether so unpracticable a person as one who deals in rhymes and not "measures" is a fair judge for other people.

Many philosophers, or fancied such, have thought they had attained the great elixir, but their time came finally, and not later than for others, to shuffle off this mortal coil. Ponce de Leon could not live long enough to exemplify the action of the Florida waters; and it is even thought now that Florida air goes farther to prolong life than ever did its far-famed waters.

Some authorities assert that longevity may be secured by the exercise of increased human prudence; that a man who could not be expected to reach *seventy* or *eighty* years, because of delicate constitution, may actually attain the age of 100. We know that prudence contributes in all to length of days, barring the accidents of life; yet the laws of development, growth and decay are too generally recognized for thousands of years past for us to believe that we can, of our *own* volition, by *any* special system of training or of feeding, protract our ages to the full term of Methusaleh. Writers on vital statistics, like Bacon, Buffon, Flourens, Hufeland and others, have given valuable information, as far as they could, on this subject; yet their writings are more like fairy tales than statistics really. Lord Bacon thought the ancients possessed some secret (art) of prolonging life and that this secret had been lost, but that diligent research might restore it; but in this search he failed hugely. In the *Encyclopædia Britannica* some one suggested that the people, before the deluge, regained their vital powers by now and then partaking again of the "Tree of Life," just as the gods fed on ambrosia and slaked their thirst on nectar.

Buffon, the naturalist, thought that in early days the earth was less solid and compact than now, and that the laws of gravitation operated more feebly. When we hear of men in the olden days living to be of such fabulous ages, we do not exactly know how long was the year in those days.

There is all the difference in men. Some are born lazy, and, like repliles, continue so all their lives. Others are ever on the move or on the watch, either to do good to themselves or to humanity. Some do not know when they get old or feel the encroachments of age and decay. Delfrench, at 120 years of age, wanted to re-enlist as a soldier; while an old soldier in the district of Polosk, in Russia, was 160 years old, and had seen seven successive sovereigns.

Man grows about the slowest of all animals. Many cold-blooded animals have an almost indefinite period of life. They go slowly, and they live long, as the tortoise; and yet the eagle is a long-lived and active bird. The carp-fishes in the lake at Fontainebleau, in France, many of them still show, on rising to the surface, the rings which Diana of Poitiers, in the days of Francis the First, had caused to be placed in their noses. Some of these fishes are blinded and almost blacked, yet they still live on, as large as sturgeons, some of them. Halier says there are individuals who have lived to 120, 140 and 160 years, to say nothing of Thomas Parr, of England.

Man is like a forced plant in these modern days—like a sprout in the hot-house. Precocious education ends in early death or in worse things. The temperature of the biceps muscle at rest is two degrees less than after sawing wood for a few moments, and yet the arm is the better for the exercise. Without exercise, the appetite fails and growth becomes retarded, where we fail to eat and to assimilate the proper amount and kinds of food.

Attempts have been made to build up theories for the prolongation of life. Some have thought that a diet suitable to each period of growth would accomplish the end and prolong life to the full one hundred years. Flourens stated the length of life to be a multiple (*five*) of the period of growth, which usually ends when the bones become united to their epiphyses. Then judging twenty years for that growth and union, he argued that one hundred years should be the normal period of life. Experience has shown that neither labor nor rest will do much more toward prolonging life than if no special care is taken. Yet it has been observed that an active, indeed a fatiguing life, during the first half of a man's existence, conduces to old age, but that the latter half of his life should be uniform and peaceful.

Cornaro, an Italian nobleman and a centenarian himself, declared that a man at fifty years of age had attained but half his life. Even Japanese girls attain their majority at fifty years.

Good living is considered in England so conducive to longevity that even the "Roast Beef of Old England" has become one of her naval airs. It is the "merry heart that makes glad" that promotes long life, and which keeps its owner "with loins ever girded, alert for an expected call," and not like the cynic referred to by Beecher as the "human owl, vigilant in darkness and blind to the light." How grand if we could all live, like Mrs. Dalton, to the age of 102 years, and who smoked until she was 100 years old, and then stopped it for fear the habit might shorten her life; better far than being like the Laplanders, who all look alike and appear like Minerva in being all of the same age, or like Cartaphilus, who never gets beyond one hundred years, always returning to the original thirty years.

The physician should know as well how to let live as to live himself—"to let life in as well as to keep death out;" and to know how to live and to apply that knowledge has been man's aim since creation's dawn.

Seth lived 912 years.
Enos lived 905 years.
Cainan lived 910 years.
Judith lived 105 years.

For some years I have been compiling from reliable sources the following list of persons who are known to have lived a hundred years or more:

Monsieur Chevreul, France, aged 103 years, living 1888.
Mrs. Stillwaggon, Long Island, aged 103 years, living 1888.
Miss Rebecca Russell, Brighton, Md., aged 100 years, living 1888.
Zephoniah Bunce, Port Huron, Mich., aged 100 years, living 1888.
James Cameron, Albany, N.Y., aged 105 years, died 1883.
Sloan, Catharine, Roanoke, Va., aged 100 years, living 1888.
Perkins, George S., Norwich, Conn., aged 100 years, died 1888.
Ryder, Jane, Orrington, Me., aged 103 years, living 1887.
Muckleweid, Mrs., Page County, Va., aged 110 years, died 1884.
Fielder, John, Laurens County, S. C., aged 107 years, living 1888.
Wheeler, Agnes, Carthage, Tenn., aged 106 years, died 1888.
Heal, Chesley, Learmount, Me., aged 109 years, died 1888.
Gordon, Jeffery, San Diego, Cal., aged 107 years, living 1888.
Muncey, Jacob, Elkton, Va., aged 116 years, died 1888.
Hickey, Ann, Great Barrington, Mass., aged 105 years, died 1893.
Hadden, Mrs., Dinwiddie County, Va., aged 102 years, died 1874
Stravarides, George, Smyrna, Asia, aged 132 years, died 1876.
Casterwelder, Mrs., Frederick County, Md., aged 114 years, died 1877.
Smith, Osterdock, Mrs., Frederick County, Md., aged 103 years, living 1875.
McKay, Margaret, Fort Royal, Va., aged 102 years, died 1888.
Steele, Alletus, Passaic, N. J., aged 105 years, living 1875.
Valentine, Nancy, Cumberland, Md., aged 100 years, living 1875.
Chapin, E. B., Dr., Charlotte, Mich., aged 105 years, living 1875.
Authors, Hester, ——, aged 115 years, died 1875.
Najoleki, Mrs., Kamoinken, aged 103 years, died 1575.
Cornaro, an Italian, Italy, aged 100 years, died 1566.
Cugna de Numas, Bengal, aged 370 years, died 1556.
Mann, ——, Haritz, Bavaria, aged 105 years, died 1875.
Bœhm, Father, New Jersey, aged 101 years, living 1875.
Locke, Nelly, Millwood, Md., aged 111 years, died 1875.
Bowie, John, —— ——, aged 102 years, died ——
Johnson, Nath., Frederick, Md., aged 104 years, died 1875.
Wilson, Sol., Jackson Co., Ind., aged 104 years, living 1875.
Carter, Elijah, Balt., aged 100 years, died 1875.
Long, Moses, Kentucky, aged 111 years, died 1875.
Allen, grandson of Ethan Allen, aged 101 years, died 1875.
Landsperger, Catherine, Balt., aged 106 years, died 1875.
Duvall, Alice, Mrs., Pr. Geo. Co., Md., aged 100 years, died 1876.
Bogart, Albert, Paterson, N. J., aged 103 years, died 1882.
Hansborough, Mrs., Culpeper, Va., aged 107, died 1859.
Jones, Henry, Balt., aged 112, living 1882.
Files, Sarah, Clifton, Ohio, aged 100 years, died 1875.
Royal, Peter, Lee Co., Va., aged 105 years, living 1875.
Lether, ——, Balt., aged 105 years, living 1875.
Baynor, Sally, Balt., aged 101 years, living 1875.
Potter, Mrs., Balt. Co., Md., aged 101 years, died 1875.
Falkner, Ro., Warrenton, N. C, aged 105 years, living 1879.
Williams, Jennie, York, Pa., aged 105 years, died 1875.
Ann of Earls, Barton, Eng., aged 100 years, living 1876.
McIlleor, Griffintown, aged 105 years, living 1879.
Holgate, Dr., Salem, Mass., aged 100 years, died 1829.
Mafelsky, Kammonken, Prussia, aged 103, died 1877.
Laherbush, Capt., London, aged 100 years, living 1874.
McKim, Wm., Rich'd, Va., aged 130 years, died 1818.
Kentz, Elizabeth, York, Pa., aged 103 years, died 1766.
Somet de la John, York, Pa., aged 130 years, died 1766.
Tarrance, Dick, Clinton, N. C., aged 100 years, living 1877.
Smith, Jas., Princess Anne, Md., aged 109 years, died 1880.
Brooke, Wonder, Pr. Ed. Co., Va., aged 126 years, died 1819.
Johnson, Isabel, Toronto, Can., aged 110 years, died 1880.
Spencer, Eleanor, Accomack Co, Va., aged 121 yrs., died 1771.
Adams, Frances, Balt., aged 104 years, died 1877.
Lange, Chas., Campbell Co., Va., aged 121 years, died 1821.
Dougherty, Mary, Phœnixville, Pa., aged — yrs., living 1880.
Roberts, Charles, Bullspen, aged 116 years, died 1779.
Welsh, Benj., Balt., aged 108 years, living 1877.
Crull, Phil., Fairfax Co., Va., aged — ——, died 1813.
Holloway, Bonnie, Fauquier Co., Va., aged 115 years, died 1882.
Skelton, Mrs. Emma W., Ashburton, Mass., aged 103 years, died 1881.
Rudisell, Polly, Miss, York, Pa., aged 99 years, died 1882.
Rudisell, Mrs., York, Pa., aged 111 years, —— ——.
Webster, Dora, col'd, Phila., aged 105 years, died 1881.

* From the *Virginia Medical Monthly.*

Gassoway, Margt., Phila., aged 106 years, died 1881.
Brouch, Cath., Mrs., Boston, aged 111 years, died 1882.
Wingfield, H. Sally, Mrs., Chicago, aged 111 years, died 1882.
Speade, Ann, New York, aged 105 years, died 1882.
Frazier, Sallie, col'd, Harrisburg, Pa., aged 102 years, died 1882.
McElroy, Mary, Greensburg, Ind., aged 106 years, died 1882.
Dempsey, Margt., Ellenville, N. Y., aged 111 years, died 1880.
Thomas, Charlotte, col'd, Carroll Co., Md., aged 100 years, died 1882.
Cusarp, Thos., Iowa, aged 106 years, died 1882.
Duvall, Sarah, Iowa, aged 101 years, died 1882.
Weston, E. T., Mrs., New Hampshire, aged 104 years, died 1882.
Brown, Jennie, Washington, aged 110 years, died 1880.
Thompson, Sarah, Mrs., New York, aged 101 years, died 1879.
Bogart, Alb. C., Paterson, N. J., aged 100 years, living 1881.
Brownfield, Benj., Monroe, Pa., aged 101 years, living 1880.
Graham, Lydia, Mrs., Pt. Lyon, N. Y., aged 104 years, died 1880.
Payne, Luray G., Stafford Co., Va., aged 101 years, died 1881.
Hamilton, Mary, Harford Co., Md., aged 102 years, died 1879.
Glover, Prudence, Cincinnati, O., aged 100 yrs, living 1880.
Koehler, Mary, Balt., aged 110 years, died 1878.
Jackson, John, Vienna, N. Y., aged —, died 1878.
German, Edith, Phila., aged 115 years, died 1880.
Frank, negro man, Woodstock, Va., aged 114 years, died 1820.
Taylor, Wm., Pittsylvania Co., Va., aged 114 years, died 1794.
Ingraham, Rev. Dr., Scotland, aged 103 years, died 1879.
Rice, Maria, Mrs., Lehigh Co., Pa., aged 107 yrs , died 1819.
Berkely, Alex., Charlotte Co., Va., aged 114 yrs., died 1825.
Neanœne, Mary, Mrs., N. Y. city, aged 106 years, died 1879.
Walker, Quag, Jefferson, Texas, aged 103 years, died 1875.
Valentine, Nancy, Allegany Co., Md., aged 114 years, died 1878.
Manning, Catharine, Balt , Mich., aged 106 yrs., died 1882.
Carmichael, Priscilla, Surry Co., Va., aged 103 years, died 1818.
Berkeley, Mrs. A., Charlotte C. H., Va., aged 111 years, died 1826.
Delpench, —— —— ——, 120 years, ——
Carter, Sarah, Petersburg, Va., aged 112 years, died 1825.
Farrin, Fanny, Kenonsville, N. C., aged 110 yrs., died 1877.
Worton, Mrs. Charlotte, Va., aged 111 years, died 1773.
Negro, Richmond, Va., 130 years, died 1818.
Harrison, Mrs., Brunswick, Va., aged 110 years, died 1885.
Holyoke, E. Aug., Dr., Salem, Mass., aged 101 years, living 1881.
Johnson, Washington, D. C., aged 115 years, died 1823.
Gelbert, Augusta Co., Va., aged 112 years, died 1844.
Coffer, John, Norfolk, Va., aged 120 years, died 1836.
A man in Haretz, Bohemia, aged 105 years, died 1675.
Brooks, Utica, N. Y., aged 102 years, died 1876.
Massey, Cath., Phila., aged 100 years, died 1879.
Johnson, Silby, Balt., aged 102 years, died 1881.
Routte, Joseph, Oxford, Eng., aged 100 years, ——
Atkins, Sylvanus, Valatie, N. Y., aged 104 yrs., living 1877.
Negro woman, Long Island, aged 115 years, died 1875.
Graves, Jemima, Springfield, Mass., aged 100 years, living 1875.
Smith, Lady, London, aged 104 years, living 1876.
Johnson, Maria S., Balt., aged 100 years, died 1875.
Woman, East Balt., Md., aged 102 years, died 1877.
Gittings, Mrs., Rockville, Md., aged 102 years, died 1873.
Mead, Ira, Mrs., Greenwich, Ct., aged 106 years, living 1876.
De Pouson, d'Allegre, Marquis, Paris, aged 102 years, living 1875.
Fowler, Mrs., Balt. Co., Md., aged 112 years, died 1876.
Van Ranselear, Mrs., Fairpoint, N. Y., aged 100 years, died 1875.
Blackwell, John H., Troy, N. Y., aged 108 years, died 1875.
Young, Charles, Scots Guards, aged 108 years, died 1875.
Boddy, Charles, Wrightsville, Pa., aged 115 years, died 1876.
Shaw, Betsy, Warren, N. H., aged 101 years, died 1875.
Levering, Abigail, Oxford, N. C., aged 100 years, living 1875.
Kellerhouse, Ann, Kinderhook, N. Y., aged 106 years, died 1875.
Hughes, Mary Ann, Dorchester Co., Md., aged 107 yrs., died 1876.
Labor, Monroe, Penn., aged 112 years, died 1875.
Marchand, Adela, Paris, France, aged 108 years, died 1876.
Darke, Horner, Washington, D. C., aged 112 years, died 1879.
Leopold, Elizabeth, Mrs., Graniteville, S. C., aged 107 years, died 1878.
Hinmond, North Barry, Ct., aged 100 years, died 1875
Lansperger, Catherine, Balt., aged 106 years, died 1878.
Jenkins, Harry, London, aged 170 years, died ——
Evans, Mrs., Augusta Co., Va., aged 102 years, died 1875.
Goodall, Mary, Mrs., Pequonan Bridge, Ct., aged 103 years, died 1880.
Patrick, Lucy, London, Canada, aged 100 years, died 1878.
Dempsy, Ann, Smyrna, Del., aged 100 years, died 1867.
Woman, London, aged 120 years, died 1875.
Aicha Ben Saheras, Algeria, Africa, aged 112 years, died 1879.
McClellency, Portsmouth, Va., aged 115 years, died 1876.
McLaughlin, James, Harford Co., Md., aged 100 years, died 1875.
Woman, Hungary, aged 117 years, died 1855.
Wright, Betty, Lynchburg, Va., aged 105 years, died 1879.
Wilkerson, Wm., Balt., aged 102 years, died 1875.
Jerome, Polly, New London, Ct., aged 102 years, —— 1880.
Denney, Ann, Mrs., Smyrna, Del., aged 103 yrs., died 1877.
Bullock, John, Bristol, R. I., aged 105 years, died 1876.
Foyenbacker, Betty, Barton, Md., aged 104 yrs., died 1880.
McDewett, Margaret, New York, aged 105 years, died 1875.
Coffee, Mary, New York, aged 105 years, died 1875.
Man, Horitz, Bohemia, aged 105 years, —— 1875.
Bandeau, Michael, St. Louis, aged 106 years, died 1876.
Rutter, Elizabeth, Balt., aged 100 years, —— 1875.
Morris, Susan, Phila., aged 118 years, died 1880.
Armstrong, Mechanicsburg, Pa., aged 101 years, died 1879.
Woman, Hungary, aged 112 years, died 1872.
Woman, London, aged 102 years, died 1875.
Kennon, Lucy, Kentucky, aged 123 years, living 1876.
Michael, Edward, York, Pa., aged 108 years, died 1876.
Haling, Phœbe, Point Pawnee, Vt., aged 105 yrs., died 1878.
Woman, Omaha, aged 100 years, living 1877.
Wallback, Mrs., New York, aged 100 years, died 1878.
Bratt, Nicholas, Hart's Falls, Mass., aged 100 years, —— 1879.
Woman, Almshouse, N. Y., aged 103 years, died 1876.
Ingram, Dr., Wrist, Scotland, aged 100 years, died 1876.
McGavey, Bayou, Louisville, Ky., aged 105, —— 1879.
Wood, Mrs., Pr. Geo. Co., Md., aged 105 years, died 1850.
McGarity, Kate, Mrs., Balt., aged 100 years, died 1878.
Wood, Mrs., Pr. Geo. Co., Md., aged 100 years, died 1846.
Cornise, Henry, Dorchester Co., Md., aged 107 years, living 1879.
Schnebly, Mary W., Mrs., Hagerstown, aged 103 years, died 1876.
Woodruff, Roxana, Vineland, N. J., aged 100 yrs., died 1876.
Gorman, Patrick, Ottawa Co., Mich., aged 110 years, died 1879.
Bardsley, Simon, Balt., aged 110 years, died 1876.
Darr, Phillip, Warren Co., Va., aged 105 years, died 1876.
Hawley, Hamit, Boston, aged 103 years, living 1875.
West, Benj., Balt., aged 109 years, died 1879.
Labor, Monroe Co., Pa., aged 112 years, died 1872.
Bass, Thomas, Phila., aged 107 years. died ——
Mahoney, Margaret, Boston, aged 109 years, died 1879.
Maiden, Ladya, Stonaway, aged 115 years, living 1880.
Truly, Dolly, Balt., aged 105 years, living 1880.
Hall, Margaret, Mrs., Baptist Home, Phila., aged 104 years, living.
Brink, Maria, Mrs., Highwood, N. Y., aged 100 years, living 1876.
Jones, Alice, Miss, Talbot Co., Md., aged 100 years, died 1876.
Gilbert, Jane, Mrs., Balt., aged 102 years, living 1879.
Patsy, Aunt, Washington, D. C., aged 115 years, died 1876.
Crier, Lilly, Balt., aged 108 years, died 1879.
Smith, Jno., Phila., aged 104 years, died 1876.
Armstrong, Robt., Newburg, Ont., aged 100 yrs., died 1879.
Groom, Esther, Princeton, Ky., aged 120 years, living 1876.
McGregor, Milby, Berlin, Md., aged 108 years, died 1877.
Carter, Esther, Fauquier Co., Va., aged 140 years, died 1858.
Conrad, Richard, Montgomery Co., Pa., aged 109 years, died 1877.
Whalley, Edwin, Eastern Shore of Md., aged 103 years, died 1718.
Montpensier, Jude, Balt., aged 100 years, living 1879.
Sprinklar, Sarah, Balt., aged 103 years, died 1880.
Harry, colored, Balt. Co., 11th District, aged 110 years, died 1877.
Farny, Fanny, Mrs., North Hampstead, Pa., aged 103 years, living 1877.
Gary, Margaret, Mrs., Coborrus Co., N. C., aged 116 years, died 1877.
Pratt, Trueman, col'd, Balt., aged 102 years, died 1877.
Carrigan, Patrick, New York, aged 104 years, died 1878.
Padestaoneta, Augla, Mrs., Cin., O., aged 109 yrs., died 1878.
Turner, Larkin, Georgia, aged 110 years, died 1878.
Halligan, Patrick, Balt., aged 101 years, died 1878.
Joynes, Amy, col'd, Accomac Co., Va., aged 105 years, living 1878.
Kretzen, Eliz., Mrs., Balt., aged 108 years, died 1882.
Doran, Barney, New York, aged 106 years, living 1879.
Olixir, Lydia, Balt., aged 109 years, died 1879.
Edison's grandfather lived 103 years.
Edison's grandmother lived 107 years.
Shelton, Patsy, Christiansburg, Va., aged 115 yrs., died 1880.
Steadwell, Ellen, col'd, New York, aged 104 years, died 1880.
Hamilton, Ed., Harford Co., Md., aged 104 years, died 1880.
Hamilton, Jane, Harford Co., Md., aged 103 years, died 1879.
Stevenson, Cath. K. M., N. Y., aged 101 years, died 1882.
Newton, Eliza., col'd, Balt., aged 100 years, died 1880.
Brady, Lew, col'd, Westchester, N. Y., aged 107 yrs., living 1880.
Cunningham, Miss, Glasgow, aged 102 years, living 1880.
Dorsett, Dan. N., Rev., Elgin, Ill., aged 100 years, died 1879.
Kelly, Mary, Mrs., Richmond Co., O., aged 100 years, died 1881.
Thompson, Sarah, Washington, aged 102 years, died 1881.
Brady, Lewis, New York, aged 108 years, died 1881.
Mahone, Rachel, Phila., aged 100 years, died 1881.
Cornaro, Italy, aged 100 years, died 1566.
Campas, Marcellina, Havana, aged 114 years, died 1888.
Reiley, John, Frederick Co., Va., aged 107 yrs., died 1884.
Eggleston, Thos., Lincoln Co., W. Va., aged 112 years, died 1888.
Hinton, Henrietta, Balt., aged 100 years, living 1888.
Washington, Maria Catharine, Carlisle, Pa., aged 100 years, died 1888.
Marshall, Margaret, Allegheny Co., Pa., aged 101 yrs., died 1888.
Dr. Jackemoviez, Russia, aged 106 years, died 1883.
Washington, Rosetta, Louisville, Ky., aged 121 years, living 1888.
Clendennin, Chas., Allegheny Co., Pa., aged 100 yrs., living 1888.
Mahala, Thos., Sharpsburg, Md., aged 100 years, died 1888.
Besser, Sarah W., Balt., Md., aged 100 years, died 1888.
Reily, Mrs., Balt., Md., aged 104 years, died 1889.
Reily, Bernard, Balt., Md., aged 109 years, died 1888.
Dutton, Margaret, Mrs., Shelbyville, Ind., aged 102 years, ——


THE

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CROSSING INLAND ICE BROKEN UP BY RECTANGULAR CREVASSES.

LIEUT. GARDE'S EXPEDITION ACROSS GREENLAND—CROSSING AN UNDULATING PLATEAU OF INLAND ICE FULL OF FISSURES.—(From sketches by Lieut. Garde.)

## THE EXPLORATION OF GREENLAND.

Lieutenant T. V. Garde, of the Royal Danish Navy, who last spring was dispatched to survey the west coast of Greenland, having returned to Copenhagen, gives in his official report some very interesting details of his remarkable march on the inland ice plateau in the company of only two companions, Lieutenant Count Carl Moltke and the interpreter Johan Petersen. It should be pointed out that this exploration was really no part of Garde's official programme, and that he was in no way equipped for such an undertaking. It was, in fact, a "summer trip" on this almost unexplored icy continent. All three young men had taken part in Captain Holm and Lieutenant Ryder's celebrated expeditions along the east coast.

The little expedition started from the Sermitsialik Glacier, lat. 61 deg. N. Lieutenant Garde had decided that there should only he three men, as he had only two sledges, each with a load of 180 pounds. He had to be back by the end of June to continue his survey of the coast, but was provisioned for three weeks. By the aid of his boat's crew, the sledges and baggage were carried up to the edge of the ice, 1,300 feet above the sea, on the morning of June 16. At 10:30 the parties said good-by to each other, and the expedition began to march in a direction of N.E. by ¼ E., the ice being fairly good. The copious snow on the surface aided the progress, and, the weather being cool, six miles were covered that day. It then, however, became apparent that they would have to march at night and sleep in the day, a most difficult task at first, naturally, but only by this arrangement they succeeded, in the short space of thirteen days, in covering some 200 miles, or halfway across Greenland, never hitherto explored in this latitude. At night there was generally from 20 to 40 deg. of frost Celsius, so that the snow was hard. About fifteen miles inland the ice became more even. Garde's intention was to proceed at first as far as possible in the direction stated, but to march back in a more easterly direction in order to visit the "Nunatak" (lofty peaks rising above the ice) Aputajuitsok, which is considered to be the northernmost outpost of the Julianehaab Alps.

For eight days the party tramped northward, the snow being good. After the second day no more waterpools were encountered, the ice plateau sloped gently upward. The snow was virgin white, soft in the day, but hard at night. During the first hours of the night snowshoes had to be used; otherwise the party walked in ordinary stout laced-up boots. No "Nunatak" was seen, and the icy snowfield presented but a slightly undulating surface, and on the last two days the undulation disappeared too. Before them lay the endless flat snowfield as far as the eye could reach—north, south, east, west.

On June 22 (the seventh day out) the party had reached about 110 miles inland, and was, therefore, in the latitude of the Colony of Frederikshaal. The change anticipated in the landscape here being absent, Garde decided, on the 23d, to proceed some distance due east, and then shape his course southeast for the Aputajuitsok "Nunatak;" however, the snowfield remained perfectly level. The altitude was now about 7,000 feet. In spite of these tempting conditions, and the apparent fact that he *could easily have crossed the Greenland continent from west to east*—a feat never hitherto achieved in that altitude, Garde decided that his duty was rather to reconnoiter Aputajuitsok, and to ascertain the conditions of the ice around this peak. It was clear that the spur of the Greenland continent had been obtained, and the route to the east coast lay before the explorer like a macadamized highroad But duty demanded his return.

In proceeding south the lofty "Nunatak" presently came in view, and it was reached ou the 26th. Several smaller "Nunataks" were found grouped around the greater one, the whole forming a wild Alpine landscape with glaciers, rising above the ice-covered continent. It was anticipated that huge accumulations of ice and moraines would be found screwed up against the peaks, hut such was not the case; the ice stretched evenly and uniformly right up to the rocky walls, thus demonstrating that there is apparently no motion in the inland ice in the interior. This has been a much disputed question. Neither of the two highest peaks appeared ascendable; but a smaller one was ascended, and observations and measurements taken. To the northeast several other "Nunataks" were seen; while to the east appeared, like in a panorama, the whole grand and wild Alpine landscape of South Greenland. To the south and southwest the ice plateau sloped fairly evenly; but much cleft and fissured down into the Sermilik Glacier, which already, in au altitude of from 3,600 to 4,000 feet, begins to fill the valleys, although it does not reach the sea till some fifteen or twenty miles further on. Lieutenant Moltke got his camera out here and obtained some good views of these rugged parts on which no human eye had rested before. Probably the flow of the Sermilik Glacier is the chief cause of the ice lying so evenly inland around these "Nunataks."

The route back lay along the north shore of the fjord Ikersuak. Here the ice was very much rent and dangerous. The route ran from W.S.W. to N.N.W. On June 28, the final day of the wanderings, fifteen miles were covered, the last seven or so being almost impassable through the broken state of the ice. Land was reached only two miles to the west of calculations, and after the fatiguing fortnight, the delight of sleeping on the soft green heather may be better imagined than described. The next morning Garde's crew espied his tent and came to render assistance, and at night the party reached the Esquimo trading station Kagsimiut, safe and sound. The weather was fine nearly the whole time. The effect of the sun on the snow was grand to behold, and quite a surprise. Even at an altitude of from 5,000 to 6,000 feet, water could be pressed copiously from the snow in the middle of the day. On two nights only were they weather bound, *i. e.*, in an altitude of about 6,000 feet, where they were caught in a terrific snowstorm from E.N.E., with several degrees of frost—a storm the like of which none of the party had ever met with in Greenland. Curiously enough, coincident with this storm, a strong "Fohn," or soft, warm wind, blew on the coast. Throughout the whole journey meteorological observations were regularly made, while simultaneously the barometer was read at the camp on the shore hy the steersman, a very intelligent Greenlander.

Although we know that Nansen crossed Greenland in a higher latitude (lat. 65 deg. N.) in 1888, and that Nordenskjold twice, in 1870 and again in 1883, made incursions on the inland ice, covering about 200 miles, not to mention Peary and Maigaard's remarkably successful expedition in 1878, in lat. 78 deg. N., when he reached some 350 miles inland—it should be borne in mind that all these expeditions were carefully planned and equipped for the purpose in view, whereas with the Garde party such was not the case. Nevertheless, here is the fact that the three young and intrepid students of science venture boldly upon an undertaking that would have appalled many a stout Arctic *voyageur*, and accomplish as much as the carefully prepared expeditions referred to in the way of

LIEUTENANT T. V. GARDE.
(Of the Royal Danish Navy.)

adding to our knowledge of the vast mystic Polar continent—an achievement which may certainly rank among the leading Arctic ventures of the century.—*The Graphic, London.*

## THE GREENLAND EXPEDITION OF THE BERLIN GEOGRAPHICAL SOCIETY.

Particular interest is felt by the Geographical Society of Berlin in the results of an expedition to the north of Greenland, which they fitted out some two years ago. At the sitting of the Society held on November 4, 1893, Dr. Erich von Drygalski and Dr. E. Vanhoffen communicated papers on the work of the expedition, Dr. Drygalski giving a general account of their life in Greenland.

On June 27, 1892, they reached Umanak, a Danish colony on the shores of North Greenland, and selected as their base of operations a position some distance inland at the head of the Umanak Fjord. They placed their house in the hollow of a great ice cirque. East and west were the ice streams of the Great and Lesser Karajak, behind them stretched the bare expanse of the ice sheet of the interior, in front lay the open water of the narrow fjord. Dr. Stade had charge of the meteorological station; Dr. Drygalski and Dr. Vanhoffen made journeys into the interior and along coastal regions of glacier and moraine.

At first, when they ascended the Karajak, none of the Greenlanders were willing to accompany them, as they are full of superstitions about the ice wastes of the interior. Three ultimately consented, and overcame

LIEUTENANT COUNT CARL V. MOLTKE.

their fears so far as to enter with spirit into the difficulties of the tour. Bamhoo canes were fixed as marks in the ice, and the "interference area" studied where the upper ice of the Karajak streams meets the inland ice. In the winter months, Dr. Drygalski, with two trusty Greenlanders, explored the Great Karajak glacier. He took measurements on the relative rate of movement in the smoother and more cleft parts of the glacier. He tells how, as the big blocks of ice tumbled down, fine ice dust was raised, which hung like a transparent veil around the ice pillars and hummocks, sometimes catching the sun rays and glancing with color effects. Ice grottoes were found, the remnants of old water channels. In those the temperature was wonderfully high, and the ice was quite moist.

From February until June, Dr. Drygalski and Dr. Vanhoffen were engaged in a long sleigh journey to the most northerly part of the Upernivik colony, in lat. N. 73°. At this latitude the outer margin of the great ice mantle of the interior extended to the sea level. Another tour which they attempted in June had to be given up on account of the warm Föhn wind. Before their final departure from Karajak, they ascended the ice once more to take observations on the bamboo marks previously set. Dr. Drygalski attributes the movement of the ice streams to their content of water, and says there would be no motion whatever unless the melting temperature were reached. Farther, the increase of temperature in summer, due to the downward passage of heated surface water, is much greater than the decrease of temperature in winter. The warming effect of the water is at its maximum in the deepest layers of ice, where also the movement is most marked. Microscopic examination of the ice also proved that it was thoroughly penetrated with water. It will be some time before the expedition can publish their results in detail. Dr. Vanhoffen's work was mainly biological.—*Nature.*

## VENOMOUS AND POISONOUS FISHES.

Fishes, many of which are held in great esteem as an addition to our bill of fare, and which form a valuable food supply for the entire world, may, nevertheless, in some cases, prove quite dangerous to man. Without speaking of the bite of fishes of large size, such as the sharks, whose formidable teeth are so much dreaded by bathers, we desire to dwell upon the casualties that may he occasioned by these animals through stinging or poisoning. In the case of a sting, the venom enters the wound made by the spines serving as organs of defense, and the poison acts in about the same way as that of snakes, scorpions and insects. When there is a poisoning, properly so called, the toxic principle is ingested when the fish is used as food and occasions a series of organic disturbances sometimes causing death.

*Venomous Fishes.*—Among the venomous fishes may be mentioned, as particularly dangerous, the common vive, or sea dragon, *Trachinus Draco*, as well as other species of the same genus, *T. vipera* and *T. aranea*. The first named species inhabits the English Channel, the Mediterranean Sea and the ocean. This is very likely the fish that Pliny (Hist Nat., xxxii., 53) calls the *draco*, and which he says stings like a scorpion when it is taken in the hand. Its first dorsal fin is provided with five hollow spiny rays filled with glandular cells that secrete a poison in the form of drops that escape to the exterior through the bursting of the cell. In addition, there is upon the upper part of the operculum a sting that points hackward and that is grooved longitudnally and is surrounded by a membrane. In each of the grooves of this sting, and in a cavity at its base, there is a mass of glandular cells, which, when they become inflated with venom, burst and allow the liquid to reach the point of the spine. The contact of this liquid with the skin produces an excessive pain and a strong local tumefaction. Phlegmons and eschars often result, and sometimes even mortification and death supervene. At one time, police regulations required the fishermen to cut off the spines of the fish before offering it for sale. This rule is still in force on the coast of the Mediterranean, especially in the city of Cette.

The sting of the *Scorpæna antennata* and *S. grandicornis* is no less dangerous. These fish are called *rascasse vingt-quatre heures* in St. Domingo on account of the rapidity with which they cause death. Other venomous species of the genus are *S. porcus* and *S. scrofa*, sea scorpions; *S. diabolus*, sea devil; *S. bufo*, sea toad, of the Mediterranean, and *S. Mesogallica*, of the Antilles. The venom apparatus has its seat in the spiny rays of the dorsal fin. Each spine is surrounded by a sheath that secretes the poison.

It is also at the level of the dorsal fin that the venom apparatus of the *Ptevois muricata*, of the Mascareigne Islands, is located. The rays of this fin are as brittle as glass and the pain caused by the sting is intolerable.

Nadeaud and Bottard have described in detail the venom apparatus of the species of *Synanceia—S. brachio, S. horrida, S. verrucosa*, etc., fishes found near the Seychelles, the island of Mauritius, Reunion, Java, Borneo, the Moluccas, Tahiti, and New Caledonia. The dorsal fin is provided with six soft and thirteen spiny rays, each of which contains a longitudinal channel communicating with a venom sack, which is oblong and terminates in a point at its upper, closed extremity. Each reservoir contains from eight to ten glands that secrete a clear, acid liquid. The reservoir is swollen with venom, and a simple pressure suffices to cause it to burst at its upper extremity. The venom then follows the channels of the spines and enters the wound made by the latter. Without such external pressure, the animal can do no injury. The fish buries itself in the sand or hides under rocks and assumes the color of its surroundings. This renders it difficult to be seen and explains the frequency of the accidents that it causes.

The sea scorpion, or bull head, *Cottus scorpius*, of the seas of the North of Europe, carries upon the operculum three channeled spines, each of which corresponds to a venom apparatus composed of glands that secrete a poison only at the moment of spawning and that remain atrophied in the intervals. It is therefore only at spawning time that the fish is dangerous.

In the order of Plagiostomi, the *Trygon pastinaca* and *T. violacea* present on each side of the tail one or more barbed stings, the wound from which is to be dreaded. The entrance of these spines into the tissues is followed by intense pain and violent convulsions, and a person wounded by them soon succumbs if relief is not afforded him.

The *Muræna helena*, sea eel, of the Mediterranean, a fish highly prized by the ancients, who fed it in ponds constructed expressly for it, and into which Vedius Pollio caused his trangressing slaves to be flung as food for the fish, has well developed teeth connected with a poison reservoir located in the palate and containing almost a cubic centimeter of liquid. Four strong conical teeth without channels, situated upon the median line and articulated with the palate bone, are capable of moving backward and bathing in the venom. When the animal brings these teeth to a vertical position again, the mucous membrane of the palate which sheathes them is stretched and compresses the poison reservoir. The venom then flows along the teeth to the wound. On each side of these four teeth there are three or four other movable ones that likewise communicate with the reservoir.

The *Plotosus lineatus, P. castaneus* and *P. limbatus*, which are found in the Indian Ocean and off the

coasts of Japan, Malabar and the Reunion Island, also are provided with a venom apparatus, which is situated in front of the pectoral and dorsal fins. It is a fibro-vascular sack, provided with muscles and communicating with a channel in the first spine of the dorsal fin. This canal ends at a short distance from the free extremity of the sting, and it is, therefore, only necessary for the foot of a bather or the hand of a fisherman to break off the extremity of the spine in order to allow of the immediate flow of the compressed venom into the wound, which often proves fatal. The animal is incapable of using this apparatus, which is purely defensive. The same is the case with the *Doras* of South America.

The *Amphacanthus luridus* and *A. Javanicus*, of the Indian Ocean, are provided with a venom reservoir in the membrane uniting the spiny rays of the anal and dorsal fins. As in the preceding cases, the liquid exudes from the extremity of a spine.

The *Thalassophryne reticulata*, of the Pacific Ocean, is provided with two dorsal spines, communicating at the base with a peculiar venom apparatus, that can be emptied only through compression. The operculum likewise is provided with a sting pointing backward and communicating with a venom reservoir embedded in the operculum.

We may mention also as possessing analogous venom apparatus: the *Niphon spinosus*, of Japan, the spines of the dorsal and anal fins of which, as well as those of the operculum, are dangerous; the *Serranus creolus* and *S. arrara*, of the Antilles, belonging to the perch family; the *Lophius setigerus*, or bristly angler; the *Dactylopterus volitans*, or swallow fish; the species of *Apistus;* several species of *Acanthurus*. or surgeon fish, etc. Finally, the genera *Diodon* and *Tetrodon*, the individuals of which are called puffers, globe fish, or swell fish, likewise include species that inflict painful wounds.

*Poisonous Fishes.*—The poisonous fishes produce still more serious effects on those who use them as food; and it is not a rare thing for them to cause death.

The toxic properties of certain fish have been known from the remotest times. Hippocrates tells us that the Greeks anciently avoided eating fish because certain kinds were injurious to the organism. Alexander the Great forbade his soldiers to eat fish, because he was convinced that some species were capable of producing skin diseases. Galen asserts that when the conger eel, *Leptocephalus conger*, is used as food it causes a derangement of the digestive organs and a serious disturbance of the nervous system. It appears that in Japan, in the seventeenth century, there existed a law by virtue of which the children of the officers and soldiers who had died from the effects of eating a poisonous fish called *fugu* lost the right of succeeding to the profession of their father. At present, in the same country, the sale of poisonous fish in the markets is punished by a fine. In other countries, likewise, the governmental authorities have taken measures of protection, either by means of laws forbidding the sale of fish known to be poisonous, or in making known the dangerous fish to the ships arriving in the ports. Poisonous fishes are particularly numerous in certain regions such as Japan, New Caledonia, the Antilles, Brazil, and the Cape of Good Hope. We shall enumerate the principal toxic fishes in following the zoological order.

In the family of Gymnodentes, the moon-fish or short sun-fish, *Orthagoriscus*, and various globe fishes, of the genera *Diodon* and *Tetrodon*, are certainly poisonous. The *Tetrodon sceleratus*, of the Cape, is so noxious that, in addition to warnings through placards, it has been deemed prudent to exhibit one of these fishes in a glass globe on the public square of Cape Town.

In the family of Clupeidæ must be mentioned a few species allied to the common herring, such as the sardine of the Antilles, *Clupea humeralis*. the *Meletta thrissa*, the groundling or melet, a sort of herring inhabiting the seas of the Antilles and China and the coast of Brizil, and the *M. venenosa*, a species widely distributed through the waters of New Caledonia and the neighboring islands. We know from a report made in 1856 that of fifty men of the crew of the Catinot who partook of the last-named fish as food at Balade, thirty exhibited more or less serious symptoms of poisoning, and five died.

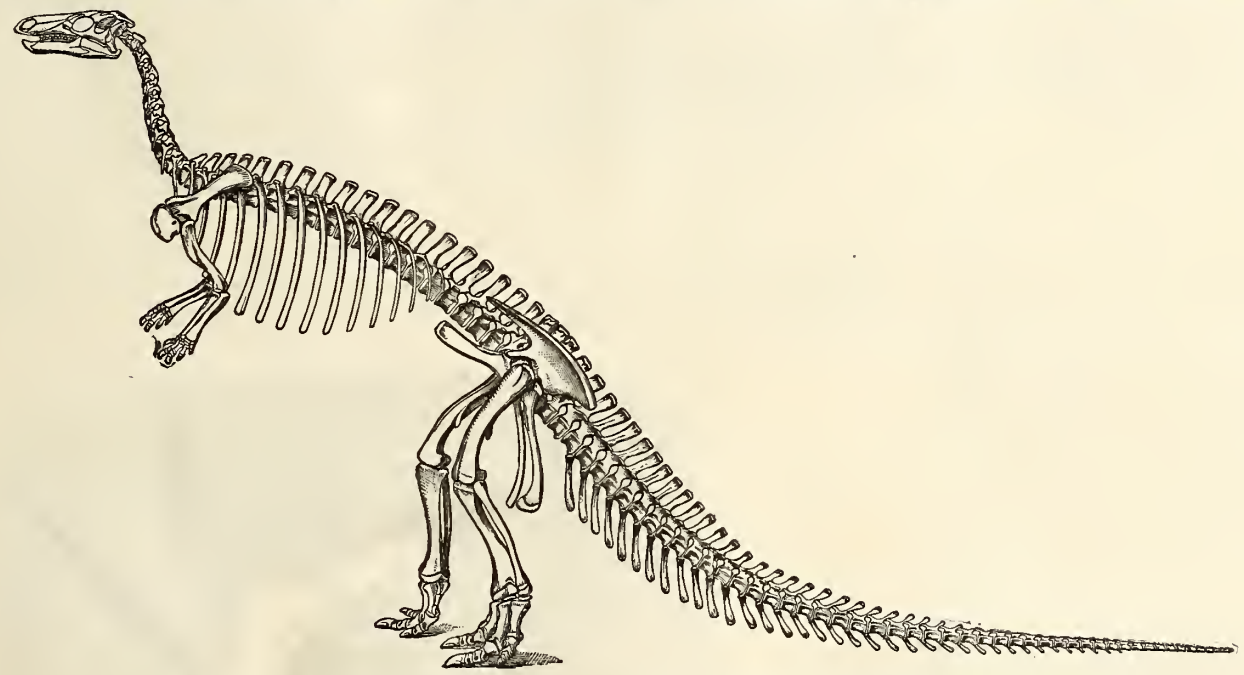
The greatest number of poisonous fish belong to the order of Acanthopterygians, and it is these that it remains for us to mention. In the Percidæ or perch family, several species of *Serranus*, found near Martinique, Guadeloupe, and Havana, prove at times very noxious. The *Anthias jocu*, of the Antilles, called the dog-toothed sardan, is very poisonous. In the family of Sparidæ must be mentioned the pager, *Sparus pagrus*, the *Chrysophrys sarba*, called parrot and paved-mouth on the island of Mauritius, and found also at Pondicherry, Hindostan, and the *Lethrinus mambo*, of New Caledonia. The family of Triglidæ furnishes the *Scorpæna grandicornis*, the sea scorpion, known at Martinique by the name of sea toad, at Havana as rascasse, and at Saint Domingo as *rascasse vingt-quatre heures* (the twenty-four hour rascasse), on account of the rapidity with which it poisons. In the family of Scombridæ we have the common tunny, *Thynnus vulgaris*, which frequently proves poisonous at Martinique and Guadeloupe, the Spanish mackerel, *Scomber Dekayi*, which, although regarded as a delicacy by some, proves positively noxious to others, and a species of *Cavaux*, which is regarded as very poisonous in Havana.

Finally, of the family of Gobidæ, the *Gobius criniger*, the hairy goby or *Calououlouve* of Pondicherry, is regarded as noxious as food.

The toxic principle of fishes acts with great celerity and affects the nervous system as well as the glandular organs of the upper part of the digestive tube. According to the observations of Dr. Remy, the symptoms of poisoning begin with nervous disorders, headache and vomiting, and continue with convulsive phenomena, paralysis and a difficulty in breathing capable of causing death.

What is the real cause of these toxic properties of fishes? Many explanations have hitherto been given that do not appear to be based upon sufficiently accurate observations; but it seems at present pretty definitely settled that it is due to a certain state of the eggs at the time of spawning. This explanation agrees perfectly with various observations that have been made for a long time back. It has been remarked that the toxic properties of fishes do not manifest themselves at all times of the year, that they vary with the age of the animals, and that the adult ones alone are truly poisonous. Finally, while certain scientists, Linnæus among them, have supposed that the poison was localized in the head of the fish, and others have attributed poisonous properties to the flesh itself, more attentive observations have demonstrated that the toxic principle is localized in certain parts of the body, and especially in the digestive tube, the liver and the eggs.

Mr. De Rochas was one of the first to attribute the poisoning caused by fishes to the action of their spawn, and consquently to their age, and he ascertained the fact with regard to certain species of New Caledonia. Messrs. Fonssagrives and Leroy de Mericourt, in 1861, adopted the same theory, while at the same time hoping that still completer experiments might be made. The researches of Dr. Remy in Japan and those of Dr. Savtschenko ("Atlas of Poisonous Fishes," St. Petersburg, 1886), are thoroughly conclusive as regards the species of the genus *Tetrodon*, which caused in dogs the same symptoms of poisoning as those observed in man after they had been fed upon the eggs and genital organs of these fish. It appears, then, that the cause of poisoning by fishes resides in a peculiar state of the eggs at the period of fecundation and spawning. Finally, it is well to add, in terminating these considerations upon the toxic principles of fishes, that, according to a comparatively recent discovery, the blood of eels and of fishes belonging to the same family contains a venom comparable with that of the viper, and which, like the venom of snakes, may be swallowed with impunity, but which, introduced into the blood, is of such a nature as to cause death. The inoculation of various animals with the blood of the eel has quickly killed them.—*La Science Illustrée and Le Magasin Pittoresque.*



RESTORATION OF CAMPTOSAURUS DISPAR, MARSH. (One-thirtieth natural size.)

[FROM THE AMERICAN JOURNAL OF SCIENCE.]

## RESTORATION OF CAMPTOSAURUS.

By O. C. MARSH.

THE Jurassic deposits of western North America contain the remains of many gigantic Dinosaurs, and various skeletons of these have been obtained by the writer, who has described the more important forms. Restorations of the skeletons of three of the most interesting genera, *Brontosaurus*, *Stegosaurus*, and *Ceratosaurus*, have already been given in this journal, and another of these huge reptiles is thus represented in the cut accompanying the present article. Each of the three forms previously restored was a typical member of a distinct group of the *Dinosauria*, and this is true, although in a less degree, of the present genus, *Camptosaurus*. Restorations of *Anchisaurus* from the Triassic, and *Claosaurus* and *Triceratops* from the Cretaceous, all Dinosaurs of much interest, have likewise been published by the writer in the present journal.*

The restoration here given is based upon the type specimen of *Camptosaurus dispar*, one of the most characteristic forms of the great group *Ornithopoda*, or bird-footed Dinosaurs. The reptile is represented one-thirtieth natural size. The position chosen was determined after a careful study not only of the type specimen, but of several others, in excellent preservation, belonging to the same species or to others nearly allied. It is therefore believed to be a position frequently assumed by the animal during life, and thus, in some measure, characteristic of the genus *Camptosaurus*. The present species, when alive, was about twenty feet in length, and ten feet high in the position here represented.

The genus *Camptosaurus* is a near ally of *Iguanodon* of Europe, and may be considered its American representative. *Camptosaurus*, however, is a more generalized type, as might be expected from its lower geological horizon. It resembles more nearly some of the Jurassic forms in England generally referred to *Iguanodon*, but, as these are known only from fragmentary specimens, their generic relations with *Camptosaurus* cannot now be determined with certainty.

In comparing *Camptosaurus*, as here restored, with a very perfect skeleton of *Iguanodon* from Belgium, as described and figured, various points of difference as well as of resemblance may be noticed. The skull of *Camptosaurus* had a sharp, pointed beak, evidently incased during life in a horny sheath. This was met below by a similar covering, which inclosed the predentary bone. The entire front of the upper and lower jaws were thus edentulous, as in *Iguanodon*, but of different shape. The teeth of the two genera are of similar form, and were implanted in like manner in the maxillary and dentary bones. In *Camptosaurus* there is over each orbit a single supra-orbital bone, curving outward and backward, with a free extremity, as in the existing Monitor; a feature not before observed in any other Dinosaur except *Laosaurus*, an allied genus, also from the Jurassic of America. Other portions of the skull of *Camptosaurus* as well as the hyoid bones appear to agree in general with those of *Iguanodon*.

The vertebræ of *Camptosaurus* are similar in many respects to those of *Iguanodon*, but differ in some important features. In the posterior dorsal region, the transverse processes support both the head and tubercle of the rib, the head resting on a step, as in existing crocodiles. The five sacral vertebræ, moreover, are not co-ossified, even in adult forms, and to this character the name *Camptonotus* first given to the genus by the writer in 1879 especially refers.† Another notable feature of the sacral vertebræ of the type specimen should be mentioned. The vertebræ of the sacrum, especially the posterior four, are joined to each other by a peculiar peg and notch articulation. The floor of the neural canal of each vetebra is extended forward into a pointed process (somewhat like an odontoid process), which fits into a corresponding cavity of the centrum in front. This arrangement, while permitting some motion between the individual vertebræ, helps to hold them in place, thus compensating in a measure for absence of ankylosis. A similar method of articulation is seen in the dermal scales of some ganoid fishes, but, so far as the writer is aware, nothing of the kind has been observed before in the union of vertebræ.

In *Camptosaurus*, the sternum was entirely unossified, and no trace of clavicles has been found. The pelvis of *Camptosaurus* differs especially from that of *Ignanodon* in the pubis, the postpubic branch being even longer than the ischium, while, in *Iguanodon*, this element is much shortened.

In the fore foot of *Camptosaurus* there were five functional digits, the first being flexible, and nearly parallel with the second, thus differing from the divergent, stiff thumb of *Iguanodon*. The hind feet had each three functional digits only, the first being rudimentary and the fifth entirely wanting, as shown in

* This journal, vol. xli., p. 339, April, 1891; vol. xlii., p. 179, August, 1891; vol. xliv., p. 343, October, 1892; and vol. xlv., p. 169, February, 1893.

† This name proved to be preoccupied, and *Camptosaurus* was substituted for it. This journal, vol. xxix., p. 169, February, 1885.

the cut. The entire skeleton of *Camptosaurus* was proportionately more slender and delicately formed than that of *Iguanodon*, although the habits and mode of life of these two herbivorous Dinosaurs were doubtless very similar.

The type specimen of *Camptosaurus dispar*, used as the basis of the present restoration, is from the Atlantosaurus beds of the upper Jurassic of Wyoming. This species and other allied forms will be described in full in an illustrated memoir now in preparation by the writer for the United States Geological Survey. The present restoration is reduced from a large drawing made for that volume.

New Haven, Conn., February 23, 1894.

## THE VOLCANO CALBUCO, IN CHILE.

Pissis, in his "Physical Geography of Chile," expresses himself as follows:

A very low gorge, nearly at the level of the plain, separates the rocky mass of Osomo from the volcano

Fig. 1.—CALBUCO AND ORNO, IN CHILE.

Calbuco, whence it extends as far as to the Gulf of Reloncavi. To the south of Jaimes (3,011 meters) are seen Villarica (2,837 meters), Quetrapillan (3,688 meters), the volcano of Cajara, Osomo (2,198 meters), and Calbuco (1,792 meters). These latter are situated entirely to the west of the Cordillera of the Andes and rise immediately above Lake Clanquihue, the altitude of which is about forty meters.

Calbuco is situated in 41° 20′ 5″ of south latitude and in 1° 59′ 8″ of longitude of the meridian of Santiago or 72° 38′ 35″ west of the meridian of Greenwich. Calbuco is a snow-covered, rocky mass, covered with thick forests. Its aboriginal name is Quillaipe or Quillepeu. Tradition preserves no remembrance of its having burned during the historic period, and yet those travelers who have traversed its base have all considered it as an extinct volcano, on account of its geological structure. The first to make the ascent of Calbuco was Mr. Charles Juliet, a naturalist attached to Mr. Vidar Gonnaz's hydrographic commission. He ascended it at the northeast side in the month of February, 1872. In the month of March of the same year, two intrepid excursionists, Messrs. Christee and Dawton, made the ascent of it and ascertained that it was a volcano. Mr. Dawton descended into the crater, but his temerity came near costing him his life. He lost his clothing and his instruments, and was unable to regain the summit until after forty-eight hours of indescribable efforts. The crater of Calbuco has the form of an irregular pentagon, slightly elongated from west-northwest to east-southeast, with a diameter of 2,000 meters. The altitude of the rim of the crater, according to a barometric observation, is 1,692 meters. The highest western edge was estimated at 463 meters, thus giving Calbuco a height of 1,738 3 meters above the level of the sea. The crater of Calbuco, when Mr. Dawton visited it, had at the bottom of its concavity a snow-covered hillock, exhibiting deep fissures that formed precipices. Gaseous emanations were proceeding therefrom.

Up to the present, Calbuco has been considered as an extinct volcano. Yet, since the beginning of last year (February, 1893), it has been awakening from its long state of lethargy and giving signs of activity. It began by projecting into the atmosphere columns of steam, followed by immense flames, accompanied with

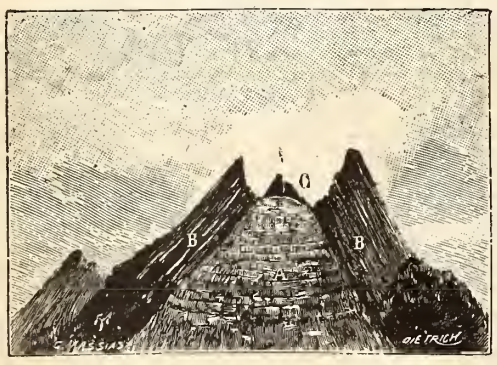



Fig. 2.—DETAILS OF THE CRATER OF CALBUCO.

A, andesites; B B, lava; C, red rocks.

subterranean noises and electric phenomena, and then an enormous outpour of volcanic sand and ashes. This eruption has not as yet (December, 1893), terminated. It is of a most remarkable character both by reason of its duration and its products. The following is the succession of the progresses of the eruption in 1893:

In February, clear, white vapors issued from the crater; in March, columns of smoke made their exit, and the snow melted on the mountain, which remained covered with a gray veil of fine ashes. The volcanic ashes and sand projected by the volcano kept increasing. The volcano threw out muddy water, which increased the torrents and covered the country traversed by them with mire. In April there were shakings of the ground, subterranean noises, and interior tempests. In May there were storms and electric phenomena; in June, earthquakes and subterranean noises; and in July, flashes of lightning, thunder, and storms unusual for the winter season. In August there was a relative calm. In September, there were five great eruptions, electric discharges, clouds of smoke and steam, and showers of volcanic ashes, that were carried to a distance of more than 120 meters. This month was marked by a great activity. In October, the quantity of ashes increased, and stones were projected from the volcano. On the 23d of this month there was a great eruption, strong commotions, detonations, a great abundance of ashes, and complete darkness during the day at Puerto Montt, Osomo, Anard, etc. On November 29 there was an extraordinary eruption, loud subterranean

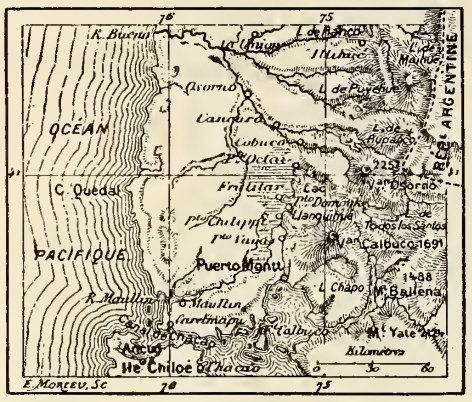



Fig. 3.—MAP SHOWING THE POSITION OF THE VOLCANO CALBUCO.

noises, heavy detonations, a fall of an enormous quantity of ashes, and electric discharges, and the sun was obscured by a cloud of ashes. In December, the eruption continued, and there were noises, flames from the crater, and ashes. Craters opened at other points of the environs of Calbuco.

The theories regarding volcanoes are well known, but since the sand, ashes, and fragments of rocks confirm our views upon volcanism, we shall recall the fact that, in the opinion of some, volcanic ashes and sand are fragments of solid rock ground up in the interior of the crater, and, in that of others, the ashes are melted lava, subdivided and pulverized suddenly by great masses of steam.

In our opinion, the ashes and sand projected by Calbuco are derived neither from molten lava pulverized by steam nor from rocks ground up in the crater by indeterminate actions. The ashes and sand are derived from the explosion of the rock itself, which bursts and is reduced to fragments when it is heated to a certain temperature. The hydrated rock, holding a greater or less proportion of water, behaves like an explosive for the water and gases that it contains. A dynamo-chemical phenomenon occurs analogous to the explosion of a wet brick thrown into a blast furnace. Water or aqueous vapor coming into contact with molten lava is capable of dividing and granulating it; but then we find in volcanic ashes and sand these nitrified fragments.

Let us now take a look at the ashes of Calbuco. I have studied the ashes and sand of this volcano, as well as the fragments of stone projected, and have examined them with a polarizing microscope. The ashes and the unmolten intact rock have exhibited to me the same mineralogical and petrological characters.

The volcanic ashes are of a light gray color. They are composed of fragments of feldspar (triclinic) more or less divided, augite, hypersthene, or amphibole, magnetite, etc. The ashes have the same mineralogical composition as the andesites whence they are derived, and, moreover, the crystallized minerals have the same form in the ashes as in the rock. An observation of prime importance is that we do not find in the ashes and sand of Calbuco the vitrified granulations that have been noticed in certain volcanic ashes attributed to molten lava divided by steam and then projected into the atmosphere. A fragment of andesite thrown out by the volcano was submitted to a coarse artificial trituration and then the pulverized material was traversed by a current of steam. I thus obtained a sand analogous to the volcanic ashes collected at the time of the eruption of Calbuco.

The eruption of the volcano has caused atmospheric disturbances; the enormous quantity of steam that has been projected into the air and the electric phenomena have destroyed the equilibrium of the atmosphere; abundant rains have fallen in the central region of Chile and also in the north; the low mountains have been covered with snow; the sky has been covered with clouds; and the hygrometric state has varied. All these disturbances, accompanied at times with tempests, are due to the influence of Calbuco. The enormous quantity of water projected into the air by the volcano returns to the earth in the form of rain and snow. The eruption continuing, the period of equilibrium has not yet arrived.—*A. F. Nogues, in La Nature.*

## RHODODENDRON MULTICOLOR MRS. HEAL

This is a beautiful addition to the race of dwarf growing and free flowering rhododendrons which has been raised at Messrs. J. Veitch & Sons' nurseries, Chelsea. The numerous forms raised require a warm greenhouse temperature and a comparatively moist atmosphere for their successful cultivation. They have been obtained from R. multicolor and R. m. Curtisi, crossed with other species and varieties, and while larger flowers have been produced, the freedom with which the multicolors bloom has been in no way impaired. The latest variety, if we may so designate it, has been named in compliment to the wife of Mr. John Heal, the skillful hybridizer and manager of the new plant department at the Chelsea nursery. The flowers, as shown in the illustration, are of medium size, pure white and borne freely in umbels at the ends of every ripened growth. The habit is dwarf and free branching and the specimen exhibited at the Royal Horticultural Society on February 13, was a center of attraction and readily obtained a first-class certificate from the floral committee. R. multicolor Mrs. Heal is, without a doubt, the finest of its race, and will, when placed in commerce, become a popular warm greenhouse shrub suitable for decorative purposes in the conservatory, or for the supply of choice cut flowers.—*The Gardeners' Magazine.*

RHODODENDRON MULTICOLOR MRS. HEAL.

## A STEEL METEORITE.

Among the many objects collected by the Peary expedition to Greenland, in 1891, was a meteorite weighing about 267 pounds. It was found by Prof. A. Heilprin, near Godhaven, Disco Island, and sent to the Academy of Natural Sciences, of Philadelphia, in the Proceedings of which (1893, p. 373) it is described by Mr. E. Goldsmith. When received at the academy, the meteorite appeared to be solid and devoid of cracks or any signs of disintegration, but this condition soon changed, and the mass slowly cracked and began to fall to pieces. It is thought that this crumbling was due to

oxidation, resulting from the existence of a higher temperature and a greater quantity of ozone in the latitude of Philadelphia than in that of Greenland. Mr. Goldsmith has examined some of the pieces separated from the mass.

The substance could easily be separated into hard, metallic, and tough granules, and a powder capable of reduction to any degree of fineness. A determination of the separated quantities gave 73·8 per cent. as the proportion of the granules and 26·2 per cent. as that of the powder. The specific gravity of the former proved to be 6·14 and of the latter 4·73. One of the pieces from the meteorite was reserved for grinding and etching, but it was found that the process involved considerable difficulty, owing to the extreme hardness of the specimen. Indeed, the mass was so hard that it would scratch soft iron, making an impression visible to the eye and sensible to the touch. This and other tests seem to warrant Mr. Goldsmith calling the object a tempered steel meteorite. Possibly the meteorite fell into a pool of water or deposit of snow or ice, and was thus quickly cooled down from the heated condition obtained by rushing through the atmosphere.

Analyses show that there is a distinct difference between the granules and the separated dark powder. The former contains a sulphuret, probably troilite; the latter contains no sulphuret, but, instead, a sulphate. Iron, nickel, sulphur, traces of carbon, chlorine, phosphorus, and chromium were found; also a silicate in which lime and magnesia were recognized. Copper and cobalt were searched for, but in vain. According to Prof. A. E. Nordenskiold and J. L. Smith, the Disco Island terrestrial iron contains copper, cobalt, phosphorus, and comparatively large quantities of carbon. As Mr. Goldsmith remarks, these differences are too great to be overlooked in comparing analytical work; they indicate that the mass found by Prof. Heilprin is not of terrestrial, but of celestial, origin.

## SOME USES OF SNOWSHOES.

WHEN a colony settles in any region, the colonists' first idea is to open up communication with the outside world for commerce and friendly intercourse. So, from early ages, dwellers in the far north of Europe and Asia sought some means of passing through the deep snow covering the mountains and valleys around them for the greater part of the year. From this need sprung the idea of snowshoes, which, in an improved form, are to this day the chief means of locomotion in most high northern latitudes during the long winter.

Originally the shoe was broad, and made either of hide or of the pliable willow. As time went on the shoe developed into a long, narrow form, as less likely to make the wearer sink into the soft snow. Further, it was found that, as the greatest difficulty in using snowshoes lay in the moving forward, a long shoe glides more easily over lightly frozen snow, and is not so likely to slip back. Different nations soon adopted different shapes and sizes, but the main idea of the shoe was identical, At present the kind most used in Norway and Sweden, as well as in other countries, for racing purposes, is the so-called "Christiania snowshoe." This shoe is very long and narrow, its furrowed sole is slightly arched, and it bends upward sharply in front. With these no stick is needed either to aid the wearer's progress or to act as drag—a great advantage if the shoes are used for military purposes. The Finnish snowshoes are also employed in the Russian army. These are extremely long, and the sole is broader than that of the Christiania shoe. Both ends bend upward slightly. However, the Finnish shoes require some kind of support in the shape of a staff as drag. This necessity interferes with the free handling of arms, so the Russian military authorities prefer to use the Russian snowshoe. Though somewhat heavier, these latter shoes are shorter and broader, besides having raised rims to the upper surface of the shoe, which support the foot, and make it easier to maintain the equilibrium. Thus, during drill or maneuvers no staff need be used, leaving the soldiers' hands free.

The use of snowshoes in warfare dates as far back as their employment for hunting or general traveling purposes. Their history can be distinctly traced from the twelfth century. Not only were they used then for racing and recreation, but they were largely adopted by scouts and messengers spying out the strength and position of an enemy. Later on, in the fifteenth and sixteenth centuries, regular snowshoe companies were formed for service in the Swedish and Norwegian wars. They were employed for any task which required great rapidity or power of movement. When a heavy snowfall prevented Charles XII.'s army from making a sudden swoop upon Norway, the Swedish king sent small detachments of snowshoers over the frontier to keep the Norwegians in a perpetual state of alarm. At the beginning of the present century Norway revived these snowshoe companies. The members were volunteers, selected from the best and most intelligent men in the army, and enjoyed certain advantages. Thus the snowshoers received higher pay than their comrades, besides being entitled to an immediate discharge at the close of the campaign. How their value was recognized may be seen from the fact that, in the middle of the present century, Norway possessed a special corps of six companies of snowshoers, mustering one hundred men to each company. Scandinavians are especially proficient because they are so accustomed to the national sport of "ski" races. To pass from the Old World to the New, the snowshoe has been familiar to the American Indians and the Canadians from the earliest period of their history. Nowadays the Canadians use the shoe for purposes of amusement only. Some of the chief features of the Quebec and Montreal carnivals are always the cunning feats and picturesque garb of the various corps of snowshoers, who go through the most elaborate evolutions.

From the days of antiquity Northern Europe has found the time for warlike operations very much limited by the difficulties of communication and the nature of the climate, with its brief fine season. Not so in Central Europe. There war is carried on under totally different conditions. An army is neither forced to go into long winter quarters nor to depend upon a good or a bad season. The generals reck nothing of wind or weather, ice or snow, but pursue a steady aim with untiring energy. The modern scheme of warfare is to break down resistance by striking swiftly and heavily; to overpower the enemy in the quickest time possible, leaving the vanquished no opportunity for rest nor for gathering together any considerable force against the invaders; to stop all trade and commerce, and to crush the national prosperity by draining the country of money and supplies for the maintenance of the attacking army within her borders. Such a campaign greatly depends for success upon the scouting, watchfulness, and rapid pursuit by the cavalry. The intelligence service between the cavalry and the main body of the army has to be kept up by the help of the field telegraph and telephone, but this is no light task, as the lines encounter numerous obstacles in passing through an enemy's land or through difficult country, especially in winter time. It is here, therefore, that the use of the snowshoe is patent. The experience of the Franco-German armies during the winter campaign of 1870–71 effectually confirmed the opinion which experts had long expressed that calvary and wheeled vehicles would be practically useless in a severe cold-weather campaign. As that experience was obtained in the relatively mild climate of France, the case would be all the more marked on a more northerly battle ground and in a mountainous or less cultivated country. Swedish history relates that at the beginning of this century a whole regiment of dragoons were destroyed by a mere handful of armed snowshoers, simply because every attempt of the riders to get near their swift-footed opponents failed in the masses of deep snow. Accordingly it seems highly probable that snowshoes would have been of the greatest service to the German troops during the winter combats in northern France, on the Loire or in the Jura, and in frustrating the repeated attacks of the French *franc-tireurs* hanging on the skirts of the German army. On snowshoes a small detachment could have ignored the difficulties of the heavy snowfall and the icy roads which so impeded cavalry operations.

It is the duty of every military leader concerned with army organization and tactics to prepare in time of peace for warfare in every possible scene of conflict, in every climate, and at every time of year. Recognizing this fact, Russia has been studying the subject of snowshoe use for more than seven years past. There is no doubt that in a winter campaign she would have a great advantage over her western neighbor through the nature of her forces alone. Not only is the patient, unassuming Russian soldier hardened against climatic influences, but he is better equipped and prepared for such an important undertaking than any of the men in other armies. Accustomed to the bitter atmosphere of his native steppes, the Russian can make himself quite happy and comfortable under circumstances where central European troops would find the weather and temperature very hard to bear. Thus, the Russian military authorities attach great weight to the fact that in the event of crossing the frontier, as planned on the Russian side of the border, their troops would be in far the most favorable position respecting customs and climatic obstacles. In the various military provinces of the Russian empire

MILITARY EXERCISES WITH SNOWSHOES.

MILITARY SNOWSHOE RACE, RUSSIA.

snowshoe drill has been practiced regularly for years past by a large number of infantry regiments, particularly by the Jager detachments, which are composed of four picked men from each company of the regiment. The following regiments are among the most efficient in snowshoe exercise: the Wyborg infantry regiment, the 86th regiment in Wilmanstrand, the whole of the 40th division, and the Finnish sharpshooters' battalions.

In the winter of 1891 the Jager commander of the above division in the military province of Kazan and the governments of Saratov, Samara, and Penza, took his men out on snowshoes for several days' training. In spite of most unfavorable weather—storms, snowshowers, and 25 deg. of cold, the men accomplished 697 kilometers in ten days. Having learned their lesson so well, the soldiers profited when they were transferred, in 1892, to the western frontier, being stationed round Bobnusk, in the military district of Wilna. The bitter snowy winter of 1892-93 gave the troops ample opportunity for snowshoeing through the vast forests of Polesie, which teem with bears, wolves, wild boars, and elks. Moreover, they were taken out in large scouting parties for snowshoe exercise with good result. They could not, however, quite equal the daily record of speed in the previous year, as the tremendous snowfall almost concealed the features of the country round. Sham fights were organized under great difficulties, where the snowshoers came out triumphant. The ordinary troops could not march through the deep snow, as they sank deep down into the soft mass. But those equipped with snowshoes glided quickly and easily along at racing pace, could wheel about in every direction, and fire, kneeling or standing, at will. Even the arrival of the reserves to support the front line and the opening of fire proceeded with the utmost speed and regularity. A similar favorable result followed when the troops were divided to simulate attack and defense, and a regular fight ensued. In consequence of this success, the crack guard regiments in the Imperial camp at Krasnoe-Selo went through similar exercises.

Always on the alert to pick up hints for her own army, Germany soon imitated Russia, while Austria followed suit. Snowshoe maneuvers were introduced in East Prussia, the Harz, the Vosges, in Hungary, and notably at Liebenburgen, in Galicia. It was found that a fortnight's instruction sufficed to make steady, agile men proficient in the exercise, and able to cover a distance of 70 kilometers in a day. The German soldiers have taken very kindly to the practice, and attain great rapidity. As Emperor William keenly enjoys witnessing any novelty in military matters, snowshoe exercises will be included in the winter maneuvers now being planned to take place near Potsdam. The only difficulty is that the winter has been too mild to provide much snow.

If we turn to the question whether snowshoe battalions will be utilized to any extent in future wars, it is not difficult, from past experience, to determine that they will play an important part when a heavy snowfall limits or prevents cavalry operations. Strong detachments of snowshoers could be attached to the cavalry divisions to assist them as scouts and sentries in the advance guard of the army. They could form part of the patrols and intelligence department, and keep the main body at headquarters in touch with the various divisions scattered about. They would be able to watch over the safety of the roads and the railway lines, go in advance to requisition provisions, succor the wounded, and fetch doctors and ambulance bearers to the place where the injured men were lying. In these branches of service the snowshoes are not only valuable for their rapidity but for their noiselessness, the thick snow effectually muffling any sound of footsteps. As the great importance which Russian military circles attach to snowshoes in warfare has so influenced German and Austrian army authorities, it might be worth England's while to consider the possibility of their use for her troops stationed near the Pamirs, or likely to be sent there. There can be no doubt that should a struggle arise with the Czar's legions in that region the Russian troops would not fail to take advantage of this latest innovation in the art of war.—*The Graphic, London.*

## HORSE TRAINING AND EQUITATION AT THE SAUMUR SCHOOL OF CAVALRY.

Captain Picard, one of the most distinguished professors of the Saumur School of Cavalry, has conceived the idea of having recourse to photography for the studies of horse training and equitation. In collaboration with Dr. Bouchard, he has just published an "Album d'Hippiatrique et d'Equitation de l'Ecole de Cavalerie"—a work of many years' labor, containing no less than thirty plates of large size, reproducing, by the Berthaud photolithographic processes, the results obtained.

This work is of interest, both from the standpoint of hippiatrics and photography.

The study under consideration bears in the first place upon the definition of the different types of horses of the French cavalry, beginning with their stock—pure English blood and pure Arabian blood.

It is certain, says Captain Picard, that these types have now assumed such relations through the fusion of blood that it is often difficult to distinguish them, and this is one reason more for fixing the traits characteristic of their country of rearing.

We give herewith two specimens of the horses represented, in selecting the breeds that are abundant in our cavalry. Fig. 1 shows a Norman horse and Fig. 2 a Vendean one.

The principles of training a horse at the school of cavalry are shown by most successful instantaneous photographs. Of this, the reader may judge from the specimens that we place before his eyes. Fig. 3 shows an exercise in the training of a horse—that of jumping a ditch, begun with the strap. Fig. 4, on the contrary, represents an exercise in the training of a cavalryman. It is the horse trained for the riding school and placed between the pillars. The cavalryman, without stirrups or reins, has to resist all the motions of the horse caused by the riding master.

Photography, so happily put to profit by the authors for representing the types of horses, the training exercises, and the studies of equitation, serves also for the teaching of many other branches of hippology. The defects of horses have hitherto been defined by anatomical drawings, which are assuredly very demonstrative, but it has appeared more practical to Captain Picard and Doctor Bouchard to represent their real aspect upon the horse through photography. The plates of the blemishes or defects are very curious. The same is the case with those relating to the school of farriery, in which are seen represented all the kinds of shoes, with the hoofs to which they are adapted.

The album terminates with a series of reproductions

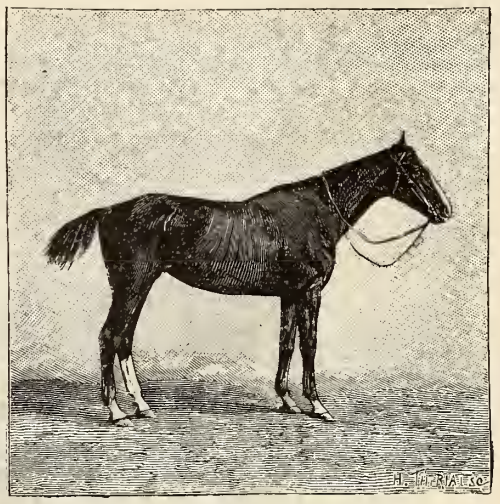


Fig. 1.—NORMAN HORSE.

Fig. 2.—VENDEAN HORSE.

Fig. 3.—TRAINING A HORSE TO LEAP A DITCH.

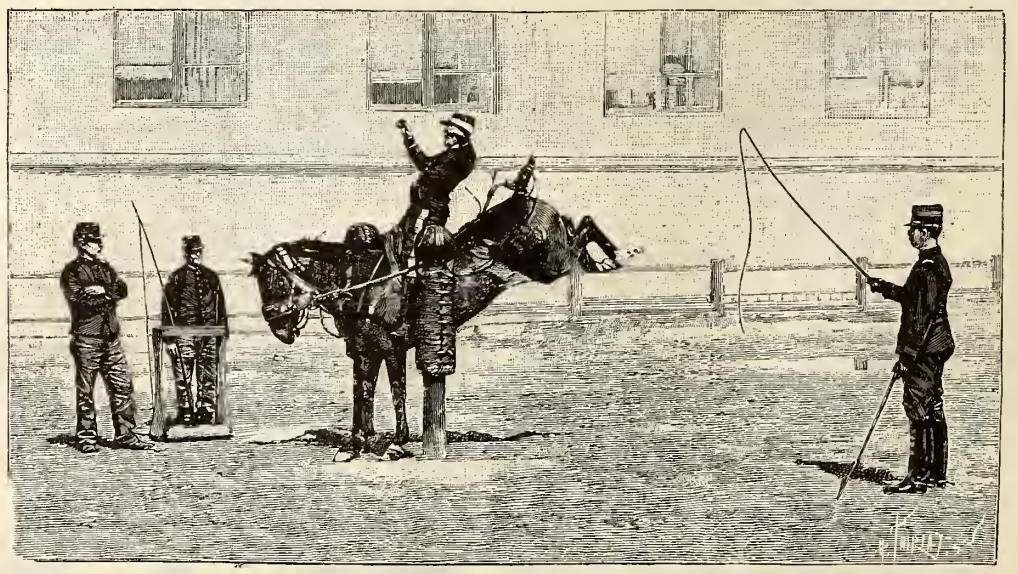
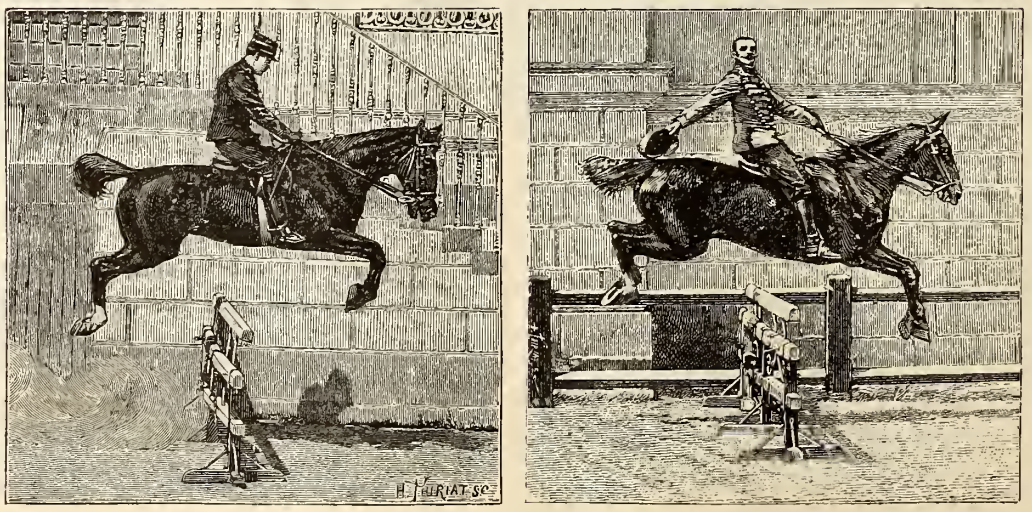


Fig. 4.—EXERCISE IN RIDING A HORSE PLACED IN THE PILLARS.



Figs 5 and 6.—JUMPING A BARRIER.

of photographs relating to the mechanism of the jump, demonstrated by a large number of horses at liberty, taken in all the successive phases of the jump. The different manners of a cavalryman's seating himself for a jump so as to avoid reactions are likewise represented from life. We have selected from the album two examples of jumping to a great height, and the horsemen in which have excellent attitudes (Figs. 5 and 6).

All these very instructive instantaneous photographs give a demonstration of the attitudes and gaits that competent men would consider as absolutely improbable.

Is it not surprising, says Captain Picard, to see, for example, photographs of horses on a racing gallop in which the animal rests upon a single foreleg, when all horsemen agree in making of the racing gallop a two-time mechanism, and horsemen reputed immovable in the saddle who are shown by the photograph displaced in the jump like young recruits.

With practice, the eye is quite capable of finding in nature what the photograph has revealed. Such education is quickly attained.

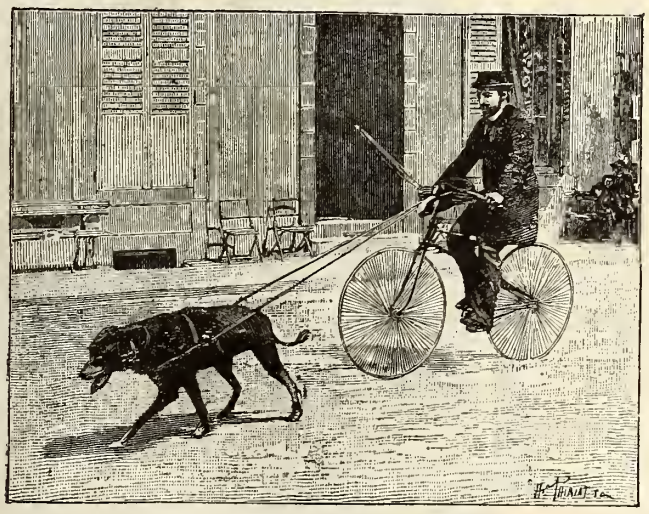
What has not one said to us, continues Captain Picard, on seeing for the first time a horse photographed in the act of jumping and represented as landing upon a single forefoot? How could this organ withstand the impact? Would it not be broken? And yet what is certainly more logical, it must be admitted that the horse divides the shock between his four limbs in placing them successively and in utilizing the pasterns as a spring.

Upon the whole, the authors of the fine work that we have just made known do not fear to assert that they have found in photography the most valuable aid for the study of hippiatrics and equitation.—*La Nature.*

## TRACTION OF BICYCLES BY DOGS.

THE bicycle, by reason of the services that it is rendering, is on the road to conquering the world. In some cities, such as Cosne, all the physicians, and in others, such as Tulle, all the sheriff's officers, go about on bicycles, and the number of road trustees and letter and newspaper carriers that employ this mode of conveyance is daily increasing. This method of traveling is at once economical, rapid, convenient, healthful and agreeable.

The progress made in cycling is due to three great



TRACTION OF A BICYCLE BY A DOG.

improvements, which have not as yet been applied to carriages and railway cars. The first is the use of balls placed between the axle and the wheel, so as to diminish friction, and the second and third are due to pneumatic tires. It is demonstrated, in fact, by mechanics, that the ideal wheel would be the one in which the spokes were perfect spiral springs. Now, the rubber tube approaches such ideal. Moreover, when a pneumatic tire comes into contact with a stone, it does not, as in an ordinary vehicle, oblige the entire load to pass over the obstacle, but allows the latter to penetrate it, so that, despite the numerous inequalities of the road, the bicycle rolls (theoretically at least) as if upon a smooth roadway. Therefore, it suffices to adapt a light motor to the bicycle in order to make long runs without any trouble—a fact worthy of consideration in mountainous countries, especially by those whose travel from one place to another should not be counted as a fatigue and be added to the day's work.

In this sense, it seems to me that the use of dogs ought to render signal services. I am able to mention, as an example, the results that I have obtained this summer at Mont-Dore and Bourbole, whither I go every day. These two thermal stations are four and a quarter miles apart, with a difference of 650 feet altitude and very steep gradients. With my bicycle, I make much better time than carriages in the descent from Mont-Dore to Bourbole, but, in order to ascend the four and a quarter miles that separate the two stations, it is necessary, in hot weather, to have at one's disposal a certain length of time for resting upon his arrival, which is something hardly possible for me. The following, therefore, is the idea that occurred to me. One of my patients owns a dog with which he easily makes from 30 to 35 miles a day. I requested him to train for me two animals for drawing a small dog cart, just as a horse would draw a small wagon. I must confess that at this time, at which I did not, as yet, know how to ride a bicycle, I had no very great confidence in the possibility of remaining upon the machine while a dog was drawing it. I consoled myself in advance in confining myself to making him draw my vehicle while I myself walked, that is to say, on steep acclivities. But what was not my astonishment and pleasure in finding my faithful Cæsar, from the first days of the experiment, saving me from all fatigue and especially drawing me rapidly. After a few days, I started in the presence of a fine assemblage of spectators, and, with my dogs on a gallop, went from Bourbole to Mont-Dore. Without a kick of the pedal, I was enabled to gain twenty minutes over ordinary carriages. Thanks to my invention, I have, therefore, been able to utilize the moments that every one takes for resting after each meal, while at the same time having myself carried rapidly and agreeably, and gaining, in going and returning, thirty minutes over carriages, and taking at will a more or less moderate exercise. I have thus effected a saving in a horse and especially in time, which is something not to be despised by one whose principal capital the latter is. I may add that every cyclist passed on the road received the offer of a re-enforcement, and more than twenty assured me that the traction of bicycles by dogs was the most agreeable thing in the world. I may add, too, that it is easier to sit upon a bicycle while a dog is drawing it than it is when one is proceeding alone. In long races, moreover, trainers do not hesitate to draw their racers, who then no longer have to occupy themselves with either the pedals or equilibrium.

Dogs have a considerable force of resistance. One day I made 20 miles of ascent on a gallop with a few minutes' rest at every 3 or 4 miles and in scarcely pedaling. Those who make use of dogs easily get from 35 to 60 miles out of them with a very poor vehicle. I know one who makes 90 miles with four dogs. It is true that in descents three dogs stand in the vehicle, that on level surfaces two only are harnessed, and that in steep acclivities the entire pack pushes or draws the wagon.

I know an amateur who has trained a dog to push along his bicycle at the side, and who, in return, generally offers him a seat on level surfaces and during descents.

If, as I hope, thanks to the aid of all those who are going to utilize my process, an arrangement be found that shall permit of ascending rapidly and of easily carrying the dog during a descent, distances of 60 miles will be made very quickly and especially without fatigue.—*Dr. Madeuf, in La Nature.*

## A SPANISH RAILWAY ACCIDENT.

THE railway accident near Pajares on the Cantabrian Mountains, in Spain, writes a correspondent of the London *Daily Graphic*, was of a rather peculiar character and shows the dangers to which mountain railways are continually exposed. The accident occurred on the afternoon of Sunday, February 18, about one and a half kilometers from Pajares, at an elevation of about 2,000 meters and during a storm of snow. The train had received a second locomotive at Busdongo, and, having climbed the steep ascent and tunnel between that place and Pajares, had commenced the descent toward the Asturias, and had run past one of the most dangerous points upon the line, where a precipice on the one side is overhung by treacherous rocks above. Entering tunnel No. 45 at a speed of about twenty miles an hour, the locomotives slightly increased their speed, when, at the month of the tunnel, where a space of only 30 meters divides it from No. 46 tunnel, a mass of rocks fell immediately in front of and upon the leading locomotive, the driver of which had only time to lay his hand upon the whistle before the machine ran upon the obstruction. The second locomotive, with the accumulated force of the train of eight coaches behind, drove the first engine clear over the mass, both being utterly wrecked as to their running gear underneath. The laminated springs carrying the axle-boxes were thrown high on the rocks on each side, and locomotive number two finished its career by sliding on one crank up a mass of rock of about two yards surface measurement. The goods "fourgon," which followed the second tender, was uninjured even as to its buffer boxes, but the succeeding third-class carriage was partly telescoped by the next, which was forced forward by a first-class coach, the body of which left its running frame entire and forced its way onto those in advance. The succeeding carriage, in the first compartment of which I found myself, was quite uninjured. The buffer boxes, which were of cast iron, were all broken off downward and trailed on the ground between the wheels. The driver and stoker of the first engine were uninjured, but the second engine driver was badly cut about the head, and seven other passengers were cut and otherwise injured. After three hours in the tunnel we were thankful for the relief locomotive, although it only hauled us out into a misery of cold fog and snow. A risky tramp round the mountain side in twelve inches of snow at dead of night finally brought us to the train sent up to bring us back to civilization.

It may give a false impression to those who know little of the Asturian province unless I add that this line, with all its dangers, is a marvelous piece of engineering, second only to the St. Gothard, and running through magnificent scenery amid mountains rich in minerals from coal to gold, and where, in parts apparently quite neglected by the European sportsman, the chamois and the bear thrive.

## THE DECAPITATION—A TRICK IN PRESTIDIGITATION.

THE stage represents a catafalque hung with black velvet ornamented with silver. In the center there is a large table with a cover that descends within a few inches of the floor.

The prestidigitator presents the subject whom he is to decapitate, lays him upon the table, and, taking a saber, cuts off his head and deposits it upon a plate ly-

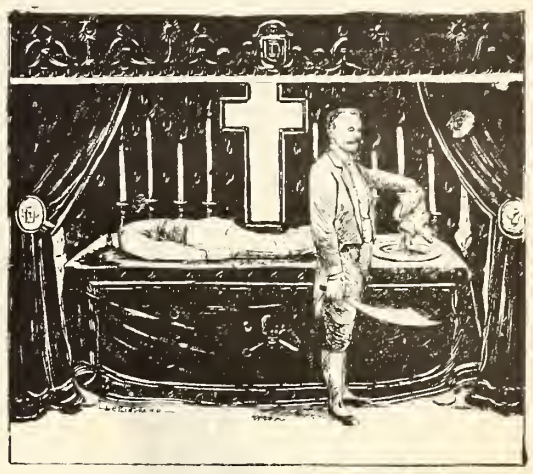


FIG. 1.—THE CATAFALQUE.

ing near the feet of the subject at the end of the table. Then the spectators are invited to pass in procession upon the stage and to touch the head in order to assure themselves that it is still living.

*Explanation.*—The table upon which the subject lies is provided with a double bottom that rests upon pegs fixed in the four legs. In this double bottom is concealed a confederate, the make-up of whose head is such as to resemble that of the person to be decapitated. A resemblance is obtained by providing the two persons with similar false beads and eyebrows. The table is provided with a trap into which the subject lowers his head. The door of the trap turns and a

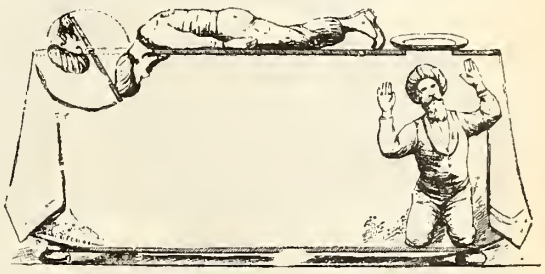


FIG. 2.—THE DOUBLE BOTTOMED TABLE.

false head places itself against the shoulders. The operator conceals this substitution by placing himself between the spectators and the subject. Then he takes a saber, passes it between the shoulders and the false head (a part of which representing the divided neck remains near the shoulders), and seizes the head by the hair in order to carry it to the plate. In carrying it he presses a button that has the effect of opening a tube whence a red liquid resembling blood escapes.

In depositing the head upon the plate the prestidigitator hides it from view.

The confederate in the table opens a trap formed in the bottom of the plate, removes the false head and causes his own to appear in place of it.

The spectators defile along the railing and may touch the head in order to assure themselves that it is living,

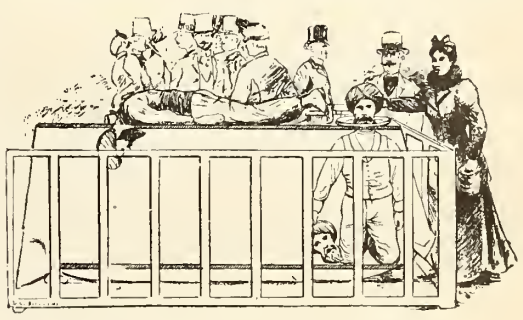


FIG. 3.—AFTER THE DECAPITATION.

but the arrangement of the railing does not permit them to touch the body.—*Le Magasin Pittoresque.*

A EUROPEAN authority on cholera believes that cholera can be exterminated by going to the root of the evil. This disease is endemic at the delta of the Ganges River in India, in a low area of about 7,500 square miles, caused by the putrefying remains of animal and vegetable life cast into the river by the inhabitants and constantly floating about. Formerly the fellaheen of Egypt interred their dead on the borders of the river Nile, and the bodies were then washed out into the stream during the annual overflow of the river, and were carried down to spread disease throughout the delta. Since an end has been put to this custom, the plague no longer harasses the country.

## WATER TUBE MARINE BOILERS.

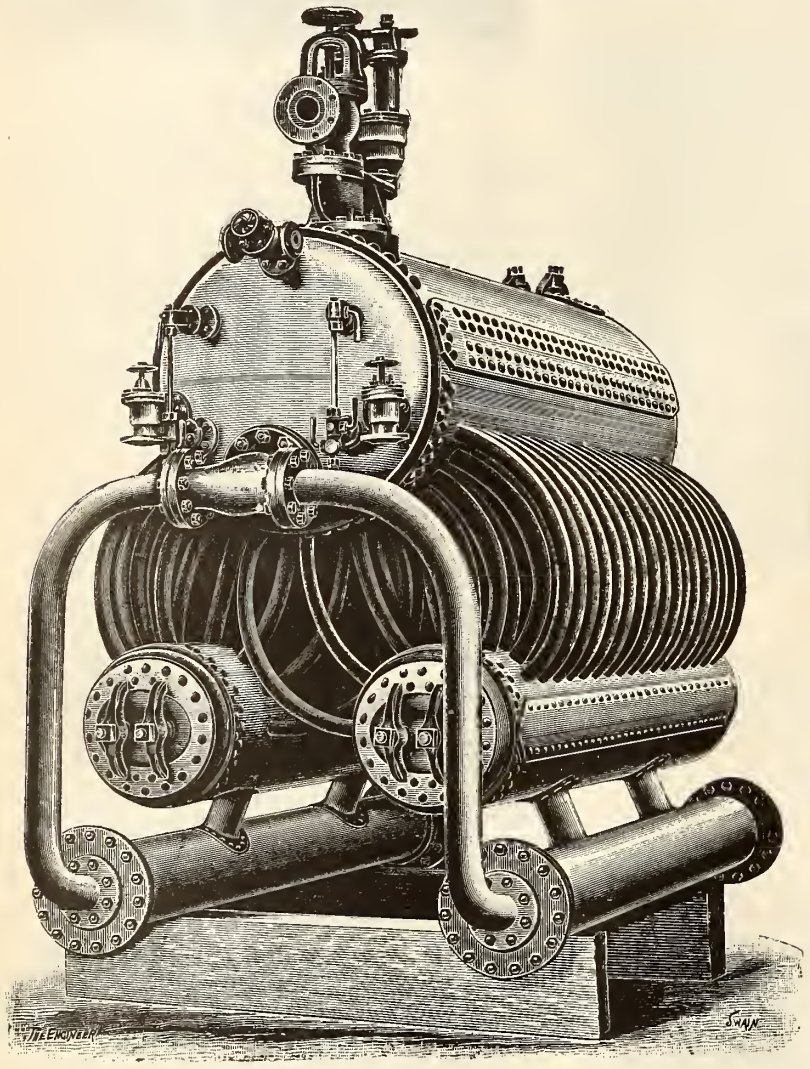
We illustrate an improved type of water tube boiler, designed and patented by Messrs. Fleming & Ferguson, engineers and boiler makers, Paisley. We are indebted to the *Engineer*, London, for our illustrations, and the following particulars. This boiler is designed with the intention of taking the place of the ordinary cylindrical fire tube boiler—not merely with the intention of making the lightest boiler possible, or one with the greatest amounting of heating surface, which is too often gained at the sacrifice of working efficiency—but a boiler that will be capable of standing the everyday wear and tear of constant service on the longest voyages. The advantages claimed for this boiler over the present multitubular boilers are, a large decrease of weight for same power and pressure; lessening of the space required in the vessel; capability of carrying the highest pressures without the necessity of using abnormally thick plates; adaptability for quick steam raising without danger of straining the boiler; large, roomy furnaces; facility of examination for cleaning and repairs; no difficulty with tube ends or other parts when using forced draught; no stays of any kind required or used, and the trouble which these give by corrosion and leakage obviated; no joints or doors in connection with tube ends.

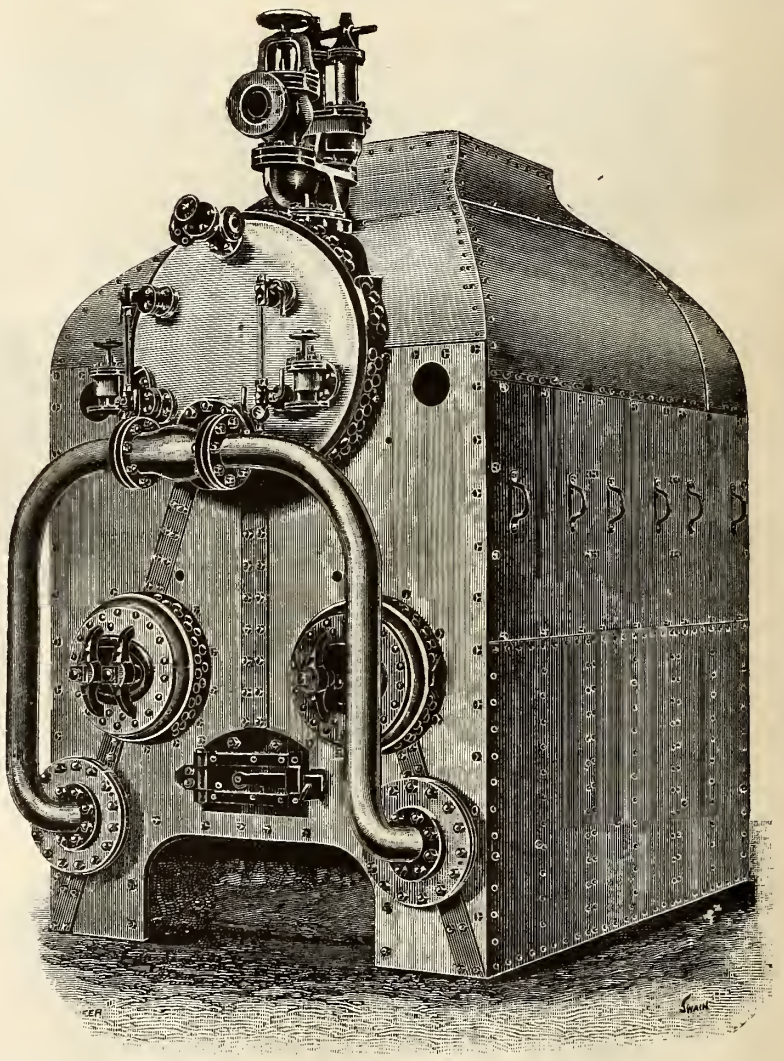
This boiler is suited for use afloat or ashore, and requires no more attention or care than the present ordinary type of boilers. It is suitable for all kinds of steamers, and can be worked, cleaned, and repaired by the ordinary class of men employed for such work. The upper drum or steam chest is of capacity which permits of the boiler being wrought without priming, working pressure of 300 pounds to Board of Trade and Lloyd's rules. This boiler was tested by water to a pressure of 650 pounds, and has been in constant use during the past year supplying steam to a set of quadruple engines driving the machinery of a large engineering and boiler works. This boiler has not given the slightest trouble in any shape or form, and although steam has been repeatedly got up in it within an hour from dead cold water, no signs of leakage have appeared anywhere.

The feed passes through coils in the smoke box, and is heated to about 100° before entering the end of the upper drum. The mud drums shown were fitted on account of the water being drawn from a rather muddy river, but in practice it was found they could have been dispensed with. In cases where deposit is likely to occur, the circulating pipes at the end of the boiler are carried down to a cross drum in which the deposit lodges, and is blown out as it gathers; the pure water only entering the lower drums from the branch above the deposit drum. This boiler since being put to work has been under inspection of the Board of Trade, Lloyd's, and British Corporation Surveyors, who all have expressed satisfaction. We are informed that on an evaporative trial with ordinary Scotch coal, it was found that when the boiler evaporated 4,400 pounds of water per hour the coal consumption was 480 pounds, the air pressure in the ashpit being 0·3 inch and temperature in funnel 480°, and when the full firing trial was made this boiler evaporated 5,500 pounds of water per hour. The casings round the boiler during the trials, which are double plated with asbestos between, were much cooler than an ordinary smoke box. Messrs. Fleming & Ferguson have in hand a set of these boilers for a steamer they are building for the Canadian government. Each boiler is to be capable of giving 1,000 horse power, and is being built to Lloyd's rules and under their survey. The working pressure is to be 220 pounds, and they are to drive a set of the builders' quadruple engines.

The following are the particulars of the various designs. All are for 200 pounds working pressure, except where otherwise stated:

| | |
|---|---|
| No. 1.—Navy type, 1 furnace— | |
| Heating surface | 1,150 sq. ft. |
| Grate area | 30 sq. ft. |
| Total weight of boiler and water, with casing and fittings | 21 tons |
| No. 2.—Two separate boilers in one casing for steamer where it is desirable to keep height and width at a minimum— | |
| Heating surface in both these boilers | 1,450 sq. ft. |
| Grate area | 44 sq. ft. |
| Total weight of boilers as above | 34 tons |
| No. 3.—Single ended two furnace boiler— | |
| Heating surface | 1,150 sq. ft. |
| Grate area | 48 sq. ft. |
| Total weight, as above | 23 tons |
| No. 4.—Double ended four furnace boiler— | |
| Heating surface | 2,200 sq. ft. |
| Grate area | 88 sq. ft. |
| Total weight, as above | 38 tons |
| No. 5.—Single ended three furnace boiler— | |
| Heating surface | 1,550 sq. ft. |
| Grate area | 60 sq. ft. |
| Total weight, as above | 31 tons |
| No. 6.—Double ended six furnace boiler— | |
| Heating surface | 3,400 sq. ft. |
| Grate area | 110 sq. ft. |
| Total weight, as above | 55 tons |
| No. 7.—Double ended six furnace boiler— | |
| Heating surface | 4,800 sq. ft. |
| Grate area | 138 sq. ft. |
| Total weight, as above | 75 tons |
| No. 8.—Single ended one furnace boiler, particulars of which are given in our description— | |
| Working pressure | 300 pounds |
| Total weight, as above | 13 tons 4 cwt. |
| No. 9.—Single ended one furnace boiler, divided into three divisions and having three furnace doors— | |
| Working pressure | 220 pounds |
| Heating surface | 1,450 sq. ft. |
| Grate area | 50 sq. ft. |
| Total weight, as above | 30 tons |





IMPROVED WATER TUBE BOILER.

## HINTS ON DESIGNING TEXTILE FABRICS.

Changes often occur which have the effect of inducing producers of fabrics to enter into styles of manufacture new to them, in order to keep trade together. Thus an employer who, for a generation, has been engaged entirely in the production of gentlemen's cloths may suddenly desire to cater for the ladies or for other branches, where ornamental patterns are required. The designer finds himself nonplussed, because, being wanting in the knowledge required for constructing an ornamental pattern, he may also be entirely deficient in the first requirement, namely, drawing. This seems somewhat incredible, but we have personally met with designers who were unable to draw a simple scroll or flower. In such a case, what results? The manufacturer must either procure outside aid or look out for another man whose abilities lie in the direction specified. It is therefore necessary that every designer, no matter in what particular line he may be, should be proficient in the first of all requirements, viz., drawing. When this has been attained, practice in the technical details of ornamental pattern construction is required, and much may be done in one's spare time.

Professors at technical schools will bear out our statement that the student who comes out at the head of his fellows at the end of each session is the one who has given attention to ornamental designing, provided, of course, that his other knowledge is up to the requisite standard. We remember the case of a student who, each session, met with much success, and we who had opportunities of seeing his works had no hesitation in saying this success was well deserved.

It has occurred to us that something might be done in these pages to aid students and a certain section of designers in search of knowledge in mastering a few details of ornamental designing, while there are numbers of our readers connected with the textile trades whose business routine may lie in another direction, but who may still find our efforts of interest and benefit to them.

*Suggestions for Designs.*—There are many experienced designers who possess abundant stores of material—illustrated art works, scraps of fabrics, wall papers, Christmas cards, and such like helps of artistic merit—which have been gathered together at various times. These are intended to assist the imagination, the fertility of which is often a matter of surprise to

the outsider. There is no doubt such things are a great help to some designers. There are others who look to nature for much of their "material" in forming patterns, whose spare time is spent in the fields, the woods, or in gardens—studying trees, flowers, foliage, birds, insect life, light and shade, etc., etc., and who seldom or never depend on artificial aids in their work. Then, again, others utilize art and nature—sometimes one, sometimes another, and sometimes a combination of the two aids. There are others who refer to nothing visible, but will commence with a blank sheet of paper before them and, with great rapidity, will sketch object after object, until a complete design is the result.

This ability and power of imagination, however, are not attained readily, but are the result of much

FIG. 1.

study, practice, and natural aptitude. The 'easy way" for a beginner is to look about and notice what objects surround him from which he may take a suggestion upon which to build up his design. It is remarkable how easily such suggestions occur to one. Anything of an ornamental nature, however simple, is of sufficient importance to be noticeable. As an instance, we take one's home. There are curtains, carpets, table covers, wall papers, the picture frames upon the walls, the plants or flowers in the garden, the carving upon the furniture. These are all suggestive, and from a scrap of any of them the student may find a "motif," and, when once his pattern is in progress, he will probably be surprised to see how little resemblance it possesses to that which gave him his idea.

FIG. 2

There are no end of everyday objects which will strike the observant mind as of use. The windows of shops are a fruitful source of suggestion to some designers, while a mind ever on the alert will find, even in the streets, that ideas strike him as he walks along. A lady's dress or mantle, the ornamental carving upon a building, and the thousand and one things which one meets with are all sources of inspiration.

*Correct Styles of Ornament.*—A designer will usually possess one or two good illustrated books of designs, which will serve to educate him in the various periods or styles of ornament, as also in the correct effects of color incidental to the respective periods or styles. In these works, the primitive, the Persian, the Indian, the Egyptian, and the various other styles are profusely illustrated, and although in most branches of what we may term "commercial" designing not much attention is paid to "correct style" or "period," it is necessary for a student to be well up in such matters, as

FIG. 3.

they tend to educate and enlarge the mind and ideas occur more freely, and finally he does not know how soon a call may be made upon him for any distinct style. There are many works published, the one known as "L'Ornament Polychrome" being among the most useful. This work contains an immense number of beautifully colored designs, which will be found an education to students.

We have spoken upon the ease with which a designer may receive suggestions, and it may be interesting and instructive to give an illustration of the manner in which a simple suggestion may be carried to a complete design. Fig. 1 shows a simple spray of lilac, which we may have noticed upon a Christmas card, or as an illustration in a book, or in its natural form in the garden. To construct a design from this is an easy matter to the experienced hand, but to a young

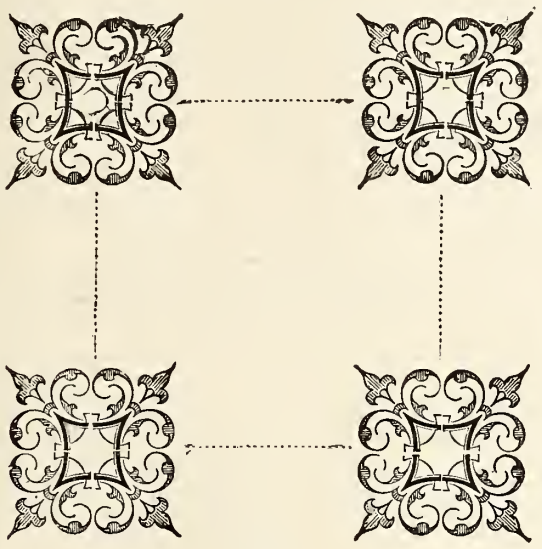


FIG. 4.

student, it is not so easy. In Fig. 2 we give the design constructed from the lilac. Of course, it is not necessary to hold fast to one particular flower. It is only the "motif"—other flowers may be introduced as desired to relieve what might otherwise be a monotonous pattern. The example is given simply to illustrate how a design may be drawn from any given object. Having dealt with the suggestive aspect of designing, we will pass on to the practical construction of

FIG. 5.

patterns, giving a few particulars and illustrations of the readiest methods of sketching designs.

*An Elementary Design.*—In the designing of a pattern, the first point to be taken into account is the size it must assume when woven. The design must be drawn to that particular size. Before proceeding further, we may say that those which repeat across or straight over form the simplest style of designing, and we, therefore, give samples of such. We will take, in the first place, an elementary pattern and will suppose

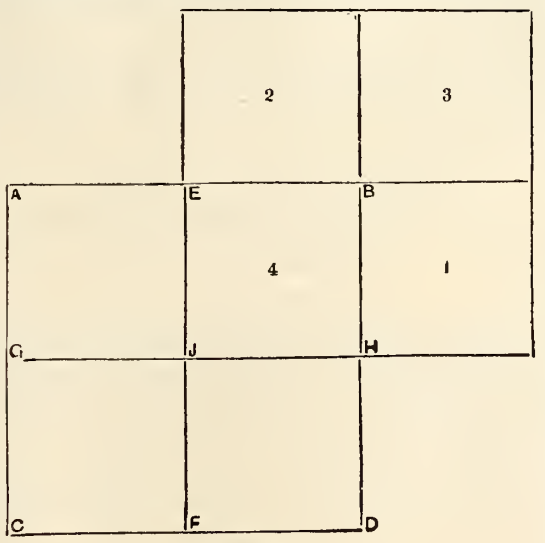



FIG. 6

the width of the woven repeat to be two inches and the length of the repeat the same. The boundary lines must, of course, first be drawn in pencil. These are represented by dotted lines, which form a square. In the center of these construct the pattern, as shown in Fig. 3. This will repeat upward and onward, at intervals of two inches, and the same will be the result wherever the position of the figure is within the boundary lines. Another method is given in Fig. 4, which will show clearly the repetition of the pattern. In this case the ornament is drawn in one corner and repeated at the other three. It is not necessary to make any further remark, beyond stating the fact that, on the ruled or point paper, a different quarter only of the ornament must appear, which will be found to join and repeat accurately when woven.

*A More Elaborate Example.*—Having given an elementary example, we will now come to one of a more

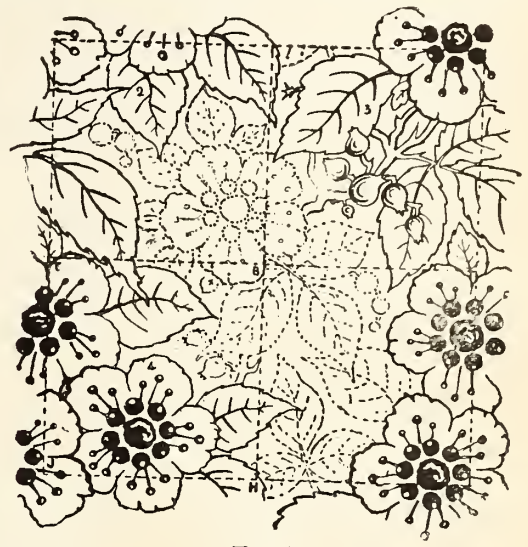


FIG. 7.

difficult character, and here again we will take a small repeat, simply as an illustration, as the actual size of a pattern of this character would be much larger, in order to look effective even in fine counts of yarn. The size of a repeat depends upon the requirements of the fabric for which it is intended and, of course, varies for different classes of cloths. We only mention this in passing. The method is the same, no matter what the size of the design may be. The boundary lines having been indicated, commence drawing the chief object—

FIG. 8.

a flower or figure—as shown in Fig. 5. And here it is necessary to remember that the pattern must be repeated, and that as much as possible without producing a liney or stripey effect, consequent upon certain patches of the groundwork or prominent portions of the figure successively catching the eye in an upward, onward, or diagonal direction. This is an error easily made, and should, therefore, be strictly guarded against. Having drawn a certain part of the pattern, the next step is to place it in its proper position, in order to secure the repeat, and this, in the case of a straight over design, requires that the ornamentation shall join at each side and at the top and bottom of the boundary lines. To accomplish this, the part already drawn must be traced. Lines E, F and G, H must be drawn. They will serve as dividing lines, showing the parts to be transferred to their respective positions, in order that the design may be completed.

An experienced designer will do this with the least possible amount of trouble, as experience suggests, but, for the novice, it will be the easiest way to construct a square of the same dimensions as A, B, C, D, in Fig. 5, a right angle of which is already shown at E, J, H, in the same figure. Having done this, continue the lines E, B and H, B as shown in Fig. 6. The portion of the pattern within the square 4 (Fig. 5) will not require transferring, but those parts within the squares 1, 2, and 3 must be transferred to the squares marked 1, 2, and 3 in Fig. 6. By referring to Fig. 7, it will be easily seen how this may be done and with what result. It will be noticed that an irregular space remains which requires filling. The continuation of the pattern has been made as indicated by the dotted lines in Fig. 7. Now trace the remainder in the squares 2, 3, 1, and transfer to their proper positions at 1, 2, 3 (Fig. 5), and a complete design will result, as shown in Fig. 8. It may be asked why not complete the pattern as shown in Fig. 7? This may, of course, be done, if preferred, but in Fig. 8 the main feature is clearly shown, while in the preceding figure it is divided. As a working pattern, sufficient is shown, but the designer may complete a square of Fig. 6, filling in his pattern, when, from the larger area covered, a better idea of its effect may be obtained.

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THE New York obelisk was brought to this country in a specially prepared vessel, the hold being opened at the bow to admit the stone.

## THE PASTEURIZING OF SILKWORMS.

By Leonard Wray, Jr., F.Z.S., Curator Perak Government Museum and State Geologist.

It is well known to all who take an interest in silk culture that this important industry, which is carried on extensively in Southern Europe, was, some years back, nearly ruined by the spread of the disease called pebrine. This disease is due to the presence of a bacterium, which is thus described by Mr. E. M. Crookshank in his "Practical Bacteriology": "*Panhistophyon ovatum*, Lebert. (*Nosema bombycis*, *micrococcus ovatus*, *corpuscles du ver à soie*) Shining oval cocci, 2 to 3 $\mu$ long, 2 $\mu$ wide, singly and in pairs, or masses, or rods, 2·5 $\mu$ thick, and twice as long. They multiply by subdivision. They were experimentally proved to be the cause of *pebrine*, *gattine*, *maladie des corpuscles*, or *flecksucht*, and were discovered in the organs of diseased silkworms, as well as in the pupæ, moths, and eggs."

The last word of this description indicates how it is that this disease is so destructive, for as it is found in the eggs, it is, of course, hereditary, and passes directly from one generation to the next.

M. Pasteur, after long and careful study of the disease and the micro-organism which causes it, suggested means whereby it was possible to detect the diseased eggs, and so insure the health of the subsequent brood, and it is not too much to say that this investigation was the means of saving the sericulture of Europe from the total extinction that threatened it.

The Pasteur system, as carried out in the South of France and Italy, is, briefly, this: Each female silkworm moth is placed in a little muslin bag to lay her eggs. After they are laid, the moth is put into a small glass mortar and crushed with a glass pestle, a few drops of water are added, and a droplet of the water is then transferred to a glass slide, covered with a cover glass, and examined under a microscope. The bacterium, being large, oval, and shining, is very readily detected with a power of about 600 diameters, and, if any corpuscles are discovered, it is certain that the moth was diseased, and the chances are that the eggs will be diseased also. Therefore, whenever the moth is found to be affected, her eggs are at once destroyed; while, on the other hand, if she is seen to have been free from disease, her eggs are kept and used for breeding purposes. There are several large firms which do nothing but produce these selected eggs for sale to the cultivators. One of these establishments employs over 300 microscopists to examine the female moths.

The spread of pebrine has been very great of late years in India, China, and Japan, and the authorities have been trying for some seven or eight years past to introduce the Pasteur system into India, but, hitherto, without any appreciable success. The reasons for this are very simple. The worm grown in Europe is an annual, and between the laying of the eggs and the hatching many months elapse, during which the process of selection can go on. For it is not necessary that the moths be examined at once; they may be kept a long time in a dry state before being placed under the microscope. Now, in India and other tropical countries the worm which is grown is what is called a "multivoltine"—that is, it has many generations in a year, and the time which elapses between the laying of the eggs and the hatching is only from six to seven days, thus limiting the time during which the selection can be carried on to about five days, if the eggs are to be sold as eggs.

The large staff of microscopists which would have to be employed to turn out any considerable quantity of eggs would be so expensive to maintain that from a commercial point of view the system would be absolutely impossible. In addition to this, it appears that to eradicate the disease from these tropical worms, one selection is quite insufficient. The system, therefore, besides being very costly, produces eggs which are by no means to be relied on as being free from disease.

In November of the year 1889 silk culture was started by some Chinese in the State of Perak in the Malayan Peninsula. Pebrine quickly made its appearance and caused serious losses in 1891, and in February, 1892, the enterprise had to be abandoned owing to the ravages of the disease. Shortly after the sickness among the worms showed itself, I tried to apply the Pasteur system to them, and arrived at the conclusion above stated, after about a year's work. In November, 1891, I began another series of experiments, which have led to results which appear to show that there is a way of applying the Pasteur system to the multivoltine silkworms of the tropics both economically and effectively.

My experiment was begun with some cocoons procured from one of the Chinese cultivators, and on a microscopical examination of the female moths, after they had laid their eggs, it was found that they were all diseased. The eggs of the least infected moths were taken and hatched, and the young worms were placed in little china cups, four worms in each. The cups were stood on a table, and they and the table were frequently disinfected during the lifetime of the worms, with a soap solution containing five per cent. of carbolic acid. Before use the house was also thoroughly disinfected by fumigation with sulphur. When any diseased worms were noticed they were at once removed and destroyed. By these means about eighty cocoons were produced, a fair proportion of the moths from which, on microscopic examination, were found to be healthy. By continuing the same procedure for three generations the pebrine was entirely eradicated from the stock, and a healthy breed established. After this, isolation in the cups was no longer necessary.

Up to this stage the experiment proved that microscopic selection coupled with isolation and rigid sanitary precautions would produce in a breed, every individual of which was infected with pebrine, a perfectly healthy race in the course of three generations, or in about four months time.

Continuing the series of experiments, it was proved that eggs laid of these healthy moths, when reared under conditions nearly similar to those which are maintained in the wards of a modern hospital, did not contract the disease during several successive generations, without either microscopic or any other selection. For nearly two years this series of experiments was carried on, and it is believed that the two facts above stated have been, during that time, placed beyond doubt.

To recapitulate, these are, first, that a healthy race may be produced in three generations from a highly diseased one; and secondly, that having once procured a healthy race, simple sanitary precautions are sufficient to guard it from contagion for several successive generations. On these two easily understood and proved facts is based the system here advocated.

This system I will now endeavor shortly to explain. A breed of say 3,000 worms, which, for convenience, may be called "firsts," would be produced in the manner already described, and maintained pure by being microscopically selected at every brood. One microscopist could examine all the female moths of each brood of this number of worms, between the laying and hatching of the eggs. A certain number of the eggs from the best cocoons would be put aside for the next generation of "firsts," and the remaining eggs would be reared in separate houses, in which strict sanitary precautions would be enforced.

This brood, which may be called "seconds," on attaining maturity would lay, but would not be subjected to microscopic selection; and it is these eggs which would be given or sold to the cultivators. They would, therefore, be always only once removed from the "firsts," or microscopically selected eggs.

If 1,200 female moths, out of the 3,000 above mentioned, were passed at an inspection of "firsts," they would yield, say 240,000, or 120,000 female "seconds;" which again would yield 24,000 000 of eggs for distribution. This number of worms would give 16½ tons of "green" or fresh cocoons, and at four broods per annum, say 64 tons, as the outcome of the work of a single microscopist for a year. This is as much as 100 microscopists could do, with multivoltine worms, if working by the ordinary method of selection as practiced in Europe. In the above computation it has been assumed that out of the 355 eggs which an average moth has been found to lay, only 200, or 56 per cent., will attain maturity. This is a large margin to allow, as it has been found by experiment that, having once obtained a pure breed, the mortality among the "seconds" does not exceed 5 per cent.

The success of the whole system depends on guarding from external sources of contagion the generation after that which has been proved to be free from disease by microscopical examination. To do this, cleanliness, the free use of antiseptics, isolation and the growing of the food in a place where it will not be infested by unhealthy worms, are the main points to be attended to. The windows and all the openings of the breeding houses should be covered with wire netting, and in a place much infested with flies all the outer doors should be double to prevent their ingress. The trays might be of zinc, and most of the other things used of the same material. These can be instantly disinfected by plunging into a pan of boiling water, or of carbolic solution, the former for preference. The tray stands should all be made of galvanized, or better, enameled, iron, and the floors either cemented or asphalted. Large houses are to be avoided both for "firsts" and "seconds," as, in case of the outbreak of any disease, small detached houses have such self-evident advantages.

From time to time it might be necessary to introduce fresh blood into the breed, and for this purpose the fresh worms should be microscopically selected for four or five generations before mixing them with the original "firsts," being kept during the probation in a house isolated as far as practicable from all the others. It may be again mentioned that I have found a single selection, never mind how carefully it is done, is insufficient to eliminate pebrine from a race of these tropical worms. Therefore, it follows that it is useless to attempt to produce "seconds" until the "firsts" have been thoroughly purged of all traces of disease by repeated selections.

In an establishment such as is here outlined, the microscopist would be the only highly paid man. All the other work could, after a little time, be done by ordinary coolies, so that the cost of maintenance would be comparatively unimportant, and the eggs could be consequently supplied at a very low price. An establishment employing three or four microscopists would suffice for the supply of a large silk-producing district. The distribution could either be made of the eggs or of the cocoons of the "seconds," so that there would be plenty of time to send them long distances. This is a matter of considerable moment, as it is of the utmost importance that the tending establishment should be as remote as possible from the cultivators. Every mile that intervenes decreases immensely the chances of the appearance of diseases of all kinds among the worms and of the presence of flies and other insect pests that attack them.

I venture to predict that this system, if carried out in the way here indicated, will do for the multivoltine silkworms of the tropics what the system practiced in Europe has done for the annual silkworms of temperate climates.

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[Continued from Supplement, No. 951, page 15197.]

## THE ART OF BOOK AND NEWSPAPER ILLUSTRATION.*

By Henry Blackburn.

*Lecture III.*

We come now to the consideration of a class of illustrations in which the artist of the future will have to come more into personal contact with the author than he has been in the habit of doing, and where the distinction I referred to in the first lecture between illustrations which are to be (1) records of facts and (2) works of art should be more clearly drawn.

Here we ask for the active co-operation of the author. The far-reaching spread of education—especially technical art education—is tending to bring together, as they were never brought before in this century, the author and the illustrator. The author of a book will give more attention to the appearance of his pages, to the decorative character of type and ornament; while the average artist will be better educated from a literary point of view, and, to use a French word for which there is no equivalent, more *en rapport* with the author. By means of the cheap processes for reproducing any lines to print with the letterpress in the pages of a book, the author will have the opportunity of explaining himself, by his own notes, diagrams, etc., on the page which he never had before. This is illustration in the true sense of the word.

How false and imaginative many of the pretty illustrations in books, especially books of travel, were, before the days of photography, every one knows. How easy it is to go astray in an illustration, without direct communication with the author of a book, is also well known.

To show how easily the cleverest artists may go astray without the aid of the author, I exemplified the other day, where the verbal description of a scene was read out carefully several times before a company of artists, while three were selected to draw upon blackboards (simultaneously and without seeing each other's work) the principal lines of composition as presented to their minds. Each was, in a sense, a work of art; each differed widely from the other, and all were wrong! The exhibition was highly stimulating and interesting, but the immediate object was to show how useless and absurd many illustrations are in books, *as illustrations*. If they are works of art they may be accepted as worthy decorations of a book; but, in the face of what photography is doing now, there is less and less demand for the imaginative landscape compositions which graced so many books of travel twenty years ago. As to purely imaginative illustrations, in which the mind in them plays the most important part, there is happily plenty of scope for the educated illustrator of to-day. But first as to

### THE AUTHOR.

Considering the small amount of interest which the author — whether historian, poet, essayist, man of science, or discoverer—seems to take in the production of his book, and the personal interest with which he might endow it, let me draw a picture of the average author of to-day—or yesterday; the "mau of letters," the student, who lives apart from the whirl of journalism and hand-to-mouth literature. The picture may be a little fanciful, but it is intended to be suggestive, not only to the author, but to all who are engaged in the production of books, whether "olde style," or otherwise.

If there be one characteristic which should enhance the interest attaching to the expression of a writer's thoughts, it should be that his individuality, or personality so to speak, should be in some way expressed on the printed page. Chaucer, Shakespeare, Milton, Scott, Byron, Dr. Johnson, and the men of letters of the past, are, each of them, deeply interesting to us in their personality, in their costume, in their handwriting, and in whatever they have left behind them as the work of their own hands. As matters stand at present, the high pressure of work imposed upon any one who has something to say is turning the picturesque figure of the "author" (as we read of him in past times) into a more or less highly strung, pre-occupied, steam-driven "literary machine."

Looking backward to the Victorian age (say from the end of the twentieth century), what pictures will be formed in the minds of those who come after us, of the *entourage* of the man of letters of to-day. Clothed in a degrading, characterless costume, which takes all appearance of manliness and suppleness from his figure, living in houses and in cities in which nearly everything ornate or beautiful has been stolen, borrowed, or copied from another country or period, he is found engaged in the production of books in which, as far as the mechanical parts are concerned, nearly everything is a sham.

The nineteenth century author's love for the literature of his past has led him to imitate not only the style, but the outward aspect of old books; and, by a series of frauds (to which his publisher seems to have lent himself only too readily), to produce something which appears to be what it is not.

The genuine outcome of mediæval thought and style—of patience and leisure—is treated at the end of the nineteenth century as a fashion to be imitated in books, such as are to be seen under glass cases in the British Museum. The twentieth century reader, looking back, will see few traces worth preserving, either of originality or of individuality.

The type founder of to-day takes down a Venetian writing master's copy book of the sixteenth century [which I will show presently on the screen] and, imitating exactly the thick downward strokes of the reed pen, forms a set of movable type, called in printer's language "old face," a style of letter much in vogue in 1893; but the style and character of which belongs altogether to the past. Thus, with such aids, the man of letters of to-day—living in a whirl of movement and discovery—clothes himself in the handwriting of the Venetian scholar as deliberately as the Norwegian disguises himself in a bear skin.

The next step is to present in his book a series of so-called "engravings," which are not engravings. The advance of science in producing blocks, from photographs of steel and other intaglio plates, for the type printing press, at a small cost per square inch, is not only taking from the artistic value of the modern *edition de luxe*, but also from its personal interest and genuineness.

The next step is to manufacture rough edged, coarse textured paper, purporting to be carefully "handmade." The rough edge, which was a necessity when every sheet of paper was finished by hand labor, is now imitated successfully by machinery, and is handled lovingly by the book worm of to-day, regardless of the fact that these roughened sheets can be bought by the pound in Drury Lane. The worst, and last fraud (I can call it no less) that can be referred to now is, that the clothing—the "skin of vellum"—that appropriately incloses our modern *edition de luxe* is made from pulp, rags, and other *debris*. That the gold illuminations on the cover are no longer real gold, and that the handsomely bound book, with its fair margins, cracks in half with a "bang," when first opened, are other matters connected with the discoveries of science, and the substitution of machinery for hand labor, which we owe to modern enterprise and invention. [Here reference was made to Mr. William Morris' exhibit of books, and to Mr. Cobden Sanderson's bindings.]

But, if it be impossible in these days (and in spite of the efforts of Mr. Wm. Morris and others it seems to be impossible) to produce a genuine book in all its de-

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* Three lectures delivered before the Society of Arts, London, December, 1893. From the *Journal* of the Society.

tails, it is worth considering in what way the author can stamp it with his own individuality; also to what extent he is justified in making use of modern appliances.

How far, then, may the author be said to be responsible for the state of things just quoted? Theoretically, he is the man of taste and culture *par excellence;* he is, or should be, in most cases, the arbiter, the dictator to his publisher, the chooser of style. The book is his, and it is his business to decide in what form his ideas should become concrete; the publisher aiding his judgment with experience, governing the finance, and carrying out details. How comes it then that with the present facilities for reproducing anything that the hand can put upon paper, the latter day nineteenth century author is so much in the hands of others as to the appearance of his book? It is because the so-called educated man has not been taught to use his hands, as the missal writers and authors of mediæval times taught themselves to use theirs. The modern author, who is, say, fifty years old, was born in an age of "advanced civilization," when the only method of expression for the young was one—"pothooks and hangers." The child of ten years old, whose eye was mentally forming pictures, taking in unconsciously the facts of perspective and the like, had a pencil tied with string to his first two fingers until he had mastered the ups and downs, crosses and dashes, of modern handwriting, which has been accepted by the great as well as the little ones of the earth as the best medium of communication between intelligent beings; and so, regardless of style, character, or picturesqueness, he scribbles away!* So much for our generally straggling style of penmanship. Looking at the handwriting of to-day, what wonder that a writer of any taste or feeling should hesitate to distribute his deformities through the world by means of *fac-simile* reproductions, and yet we desire to see the handwriting of our favorite author. But handwriting in our generation is so singularly mean and inexpressive; it has arrived at such a point of indistinctness and slovenliness among men that (it is sad to say it) refuge is now taken in the American typewriting machine.

Here it may be objected that, in the rapid movement of the world's work and thought, there is no time for considering the effect of a page, that the shorthand writer and the typewriter (one and the same person) should be close at hand to take down what we have to say. This may be so in the merchant's or lawyer's office, the warehouse, the railway station, or the newspaper office, but from a picturesque point of view, let us hope the day is far distant when an author of leisure (as distinct from the journalist) will filter out his ideas in this fashion. Anthony Trollope's record of the working of his own literary machine—of the number of words reeled off in a minute, in an hour, in a day—leaves an unpleasant sense of mechanism on the mind.

But we are told that we are shaking off our trammels, and that all these modern inventions are to set the spirit free; and so, to shorten our journeys on the road to knowledge, we are to have recourse to the "typewriter" and its most monotonous lines! Should we not rather reform our own handwriting, once for all. First study a system of shorthand for rapid notes and then learn to write so clearly and distinctly, that a *fac-simile* of it would be a delight to read on the printed page.

Consider the question in all its bearings. The time has come when, for the first time in the history of the world, any lines drawn or written can be reproduced in *fac-simile*, from which thousands of copies can be printed. There is no occasion to repeat the details; once realize the fact that your handwork can be made to appear clearly on the printed page (with little more expense than typesetting), and you—the young author, student, man of letters—will give us in the future more of your interesting personality. The thoughts may flow as before, but the vessel to receive them and convey them to others shall have its hallmark of individuality.

Thus in the future the distinction will be more clearly drawn between the work of the student on the one hand and journalism, hack literature, and "penny dreadfuls," on the other. Typesetting and uniform printing of words by the thousand will be used as before, but the "author"—for want of a better word—the poet and the scholar, who gives a book to the world, should free himself as much as possible from mechanical trammels, and boldly set to work to present himself in appropriate guise. The beautiful photographic processes which have been perfected during the last few years will *fac-simile* a page so accurately that it is wonderful that so few of our artistic countrymen have availed themselves of them. Had such processes as those now in use in England, France, and Germany been in existence in the time of the early engravers, there would probably have been no such thing as wood engraving, for chroniclers and artists, from the engraver of St. Christopher to Bewick, would have hailed the new methods with delight. What we might have lost or gained artistically cannot be considered now. The question for the moment is how to rouse sufficient interest in these matters among authors.

Let us take the poets first. They have comparatively little to do with the outer world; but the public, rightly or wrongly, is eager to know more of their personality. They, the elder, the professional poets, live, most of them, in an atmosphere of cloistered silence, of repose and picturesqueness, more akin to mediæval times than to railways and telegraphs. They come out to greet us in a garden of flowers, where Nature forms herself into pictures all around. Is it not a poor thing that they can record little or nothing of their surroundings pictorially; no mental impressions except in type-set words? With the exception of the late Lord Tennyson, it is difficult to think of any poet of our day whose personality is well known and cared for by the public. Modern dress, and the fear of appearing to "pose" in these advertising days, has led to the neglect of many outward things which the historian would hold dear.

The moral may well be drawn. Equip yourself in more ways than one for expression by the pen; to you who write, in times when it is impossible to be personally picturesque, remember that anything drawn or written by your own hand may be of interest in the future. These are things that the artist, as well as the author, may bear in mind, as in the future they will work much more in concert and consider together the setting out of a page, the harmony of text and illustrations, and appropriate ornament on page and binding.

Is the "setting out of a page" one of the lost arts, like the designing of a coin? What harmony of style do we ever see in an ordinary book? [Here reference was made to exhibits.] How many authors or illustrators of books show that they care for the "look" of a printed page? The fact is that the modern author shirks his responsibilities, following the practice of the greatest writers of our day. There are so many "facilities"—as they are called—for producing books that the author takes little interest in the matter. Mr. Ruskin, delicate draughtsman as he is known to be, has contributed little to the *ensemble* or appearance of the pages that flow from the printing press of Mr. Allen, at Orpington. How well his books are printed you can see presently, but judged by the past a deadly monotony pervades the page; the master's noblest thoughts are printed exactly like his weakest, and are all drawn out in line together as in the making of macaroni! Mr. Hamerton, artist as well as author, is content to describe the beauty of forest trees, ferns and flowers, the variety of underwood and the like (nearly every word, in an article in the "Portfolio," referring to some picturesque form or graceful line), without indicating the varieties pictorially on the printed page. Tennyson and other poets have been content for years to sell their song by the line, little heeding, apparently, in what guise it was given to the world; and so the monotony of uniformity pervades the pages, alike, of great and small, and a letter from a friend is now often printed by a machine! The last stage of feebleness and admission of incompetence in the matter of using our hands, which I may touch upon here, seems to have been reached in the indiscriminate use of the typewriter; for which, as a satirical writer lately remarked, "there is something to be said, as many of our scientific friends have been able to communicate their ideas in a letter, for the first time, by this means."

Let us now look at some slides, in illustration of what I have called the "decorative page," with and without pictorial illustrations.

1. Example of early Venetian writing, from a copy book of the fifteenth century, written with a reed pen. See the clearness of the page and its picturesqueness; also its similarity to the type letters used today—what are called "old face"—the origin of what is known as Caslon type, and of much (good and bad) letter in modern books.

2. A beautiful example of Gothic writing and ornament, from a French illuminated manuscript in the British Museum; date 1480. Here the decorative character and general balance of the page is delightful to modern eyes.

3. *Fac-simile* of a printed page, from Polydore Vergil's "History of England," produced in Basle in 1556. The style of type is again familiar to us in books published in 1893; but the setting out of the page, the treatment of ornament (with little figures introduced, but subservient to the general effect), is not familiar, because few of us can produce a decorative page. The printer of the past had a sense of beauty, and of the fitness of things, apparently denied to all but a few to-day.

4. An illuminated printed page, 1521, with engraved borders, after designs by Holbein; figures again subordinate to the general effect.

5. Example of a page, Italian, fourteenth century; ornament, initial, and letters forming a brilliant and harmonious combination.

In all these pages, it will be observed, what is called "color" in black and white is preserved throughout. Closely criticised, some of these block designs may appear crude and capable of more skillful treatment, but our object is to study the effect of a page without "illustrations," in the modern sense of the word, to see how color and breadth is obtained in pure line. In these and similar pages, such, for instance, as "Le Mer des Histoires," produced in Paris by Pierre le Rouge in 1488, the harmony of line drawing with the type letters is most interesting and instructive at the present time. It may be attained in line, but never in wash drawings, reproduced by the processes.

It is in the production of the decorative page that wood engraving asserts its supremacy still, as may be seen in some beautiful books produced in England during the past year, which we will examine after the lecture. Mr. William Morris' books, which he has kindly lent us—where artist, wood engraver, type founder, paper maker, printer and book binder work under the guiding spirit (when not the actual hand work) of the author—have been fully described elsewhere. They are interesting to us rather as exotics; an attempt to reproduce the exact work of the past under modern conditions; conditions which render the price within reach only of a few. But they are at least a protest against the modern shams of which I have spoken to-night.

From an economic and practical point of view, and as a new departure in modern illustration, I would rather point to the work produced by an art school, where an educated and intelligent mind seems to have been the presiding genius; where the illustrators, while they are fully imbued with the spirit of the past, have taken pains to adapt their methods to modern requirements. I refer to the Birmingham Municipal School of Art. While using wood engraving freely, the illustrators of Birmingham, notably Mr. Gaskin, have shown, as in the page before you, what can be done in line drawing by the relief processes, to produce color and ornament which harmonize well with the letterpress of a book. [Slide of page from Mr. A. J. Gaskin's illustrations to "Hans Andersen's Fairy Tales."] This seems an important step in the right direction, and if the work emanating from this school were less, apparently, confined to an archaic style, the heavy outline and mediæval ornament (I speak from what I see, not knowing the school personally), there are possibilities for an extended popularity for those who have worked under its influence.

[Continuing the remarks on the modern decorative page, two slides were shown of pages designed by Mr. Walter Crane, "The White Snake" and "The Geese and the Cranes." Mr. Crane's pages were cited as excellent modern examples of style, in which harmony of text and illustration have been considered. It was pointed out here how unsuitable steel engravings and fine wood cuts appear when in close juxtaposition with the type of a book.

Other slides were then shown on the screen, one of the most interesting being the enlargement of an American wood engraving from the October number of the *Century Magazine;* also a title page to an American edition of "She Stoops to Conquer"—design and lettering all drawn in pen and ink by Mr. Alfred Parsons, and reproduced by an intaglio process.]

Referring, further, to wood engraving, Mr. Blackburn said: As regard wood engraving generally in the year 1893, one has only to point to this frontispiece from the *Century Magazine*, and to continual arrivals of new illustrations from the other side of the Atlantic, to prove that wood engraving as an art, in qualities of delicacy, tone, and color, has never b en excelled. The artistic excellence of American engraving is, as we all know, a matter of capital and energy; the enormous circulation of their magazines enabling the proprietors to give wood engravers the best education possible (in Paris and other capitals of Europe), placing them on a social level with the illustrator, a very important point. Another powerful factor is the excellence of American printing.* Mr. J. Comyns Carr, lecturing in this room in May, 1882, when the possibilities of process work were less understood than now, said:

"Book illustration as an art is founded upon wood engraving, and it is to wood engraving that we must look if we are to have any revival of the kind of beauty which early printed books possess. In the mass of work now produced there is very little trace of the principles on which Holbein labored. Instead of proceeding by the simplest means, our modern artist seems rather by preference to take the most difficult and complex way of expressing himself. A wood engraving, it is not unjust to say, has become scarcely distinguishable from a steel engraving, excepting by its inferiority."

This was said more than eleven years ago, and referred especially to the elaborate and beautiful wood engravings which came from America. Speaking now, in 1893, we are bound to say that the art of wood engraving has not progressed in England in the last ten years, and that the simplicity and individuality of such work as that of Bewick is rarely to be seen in the pages of our printed books With the fine examples by Mr. W. Biscombe Gardner, and other engravers (which we shall see after the lecture), I must leave this part of the subject. Time only prevents me from mentioning other books published in England in 1893, in which artist, engraver and printer have worked well together.

In conclusion then, let me say that every one who cultivates a taste for artistic beauty in books, be he author, artist, or artificer, may do something toward relieving the monotony and confusion in style which pervades the outward aspect of so many books. It is a far cry from the work of the missal writer in a monastery to the pages of a modern book, but the taste and feeling which was shown in the fifteenth and sixteenth centuries in the production of books exist in the nineteenth (as we know), but under the difficult conditions of our times.

Many years ago the question was asked in the *Athenæum*, "Why is not drawing for the press taught in our government schools of art?" I think the principal reasons why the art of illustration by the processes is not generally taught in art schools are (1) drawing for reproduction requires more personal teaching than is possible in public schools; (2) the art masters throughout the country (with very few exceptions) do not understand the new processes, which is not to be wondered at.

It is not the fault of the masters in our schools of art throughout the country that students are taught in most cases as if they were to become painters, when the only possible career for the majority is that of illustration or design. The masters are, for the most part, well and worthily occupied in giving good groundwork of knowledge to every student, as to line drawing. There is no question that the best preparation for this work (*pace* the paragraph from the *Athenæum*) is the *best general art teaching that can be obtained.* The student must have drawn from the antique and from life; he must have learned the elements of composition and design; have studied from nature the relative values of light and shade, aerial perspective and the like; in short, have followed the routine study for a painter whose first aim should be to be a master of monochrome.

In the more technical parts which the young illustrator by process will require to know he will need more personal help than is easily obtainable in classes in schools of art. He will have a multitude of questions to ask "somebody" as to the reasons for what he is doing; for what style of process work he is by touch and temperament best fitted, and so on. All this has to be considered, if we are to keep a good standard of art teaching for illustration.

In the book of the future we hope to see less of the "lath and plaster" style of illustration, as produced from careless wash drawings by process; fewer of the blots upon the page, which the modern reader seems to take as a matter of course. In books, as in periodicals, the illustrator will have to divest himself, as far as possible, of that tendency to scratchiness and exaggeration that injures so many process illustrations, as pointed out in the first lecture. In short, he must be more careful, and give more thought to the meaning of his lines, to the adequate expression of textures and the like. There is no reason why the texture of a man's coat should look like straw, or the background to a figure have the appearance of fireworks. No amount of ability on the part of the artist will make these things tolerable in the near future.

In "the book of the future" the author may do

* It may not be generally known that in order to cover four average pages of a lady's letter, the point of the pen has had to travel over a distance of nearly one hundred feet.

* Here it should be remarked that the artist who draws for the processes in this country must not expect (excepting in very exceptional cases) to have his work reproduced and printed, as in America. He must learn to adapt himself to other conditions; this, apparently, few artists or teachers seem to realize.

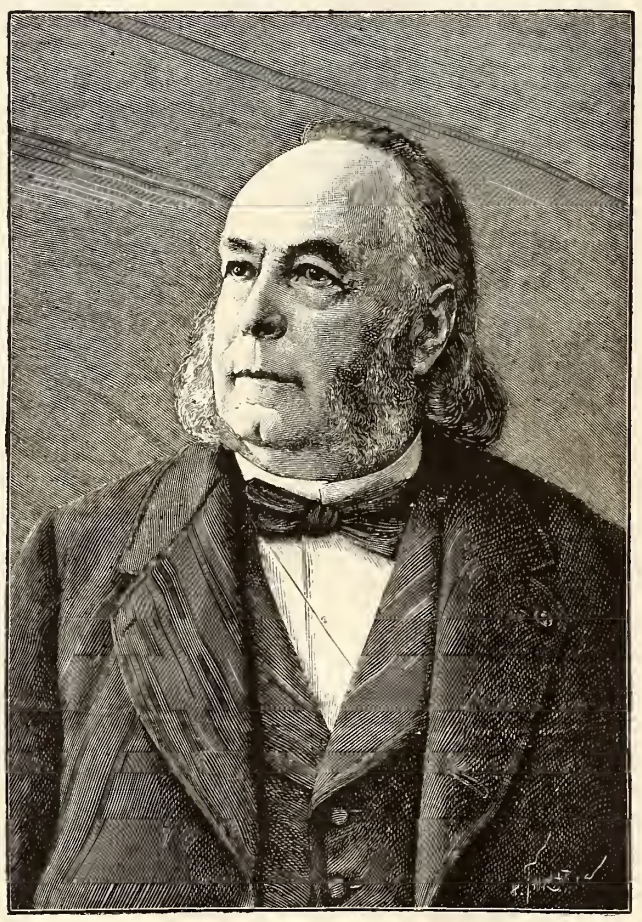
more than he has ever done, as I have already suggested; a volume of instances might be given where a writer's meaning could be more clearly expressed pictorially than verbally. The subject is not half ventilated yet, nor can I touch upon it further to-night; the day is not far distant when the power of the hand of the author will be tested to the utmost, and lines of all kinds will appear in the text. There is really no limit to what may be done with modern appliances, if only the idea is seized with intelligence; the journalist of the future will also aid unconsciously in the formation of a new language, which every nation can understand.

In conclusion, Mr. Blackburn said: In thus considering the education of the illustrator of to-day, I need hardly remind you of several modern books which come greatly to his aid. Three of the first importance are: "The Graphic Arts," by P. G. Hamerton (London; Macmillan & Co.); "Pen and Pencil Artists," by Joseph Pennell (London: Macmillan & Co.); "English Pen Artists of To day," by J. G. Harper (London: Rivington, Percival & Co.)

The value and comprehensive character of Mr. Hamerton's book is well known, but it reaches into branches of the art of illustration far beyond the scope of these lectures. Of the second, it may be said that Mr. Joseph Pennell's book is most valuable to students of "black and white," with the caution that many of the illustrations in it were not drawn for reproduction, and would not reproduce well by the processes we are considering. The third volume seems more practical for technical purposes.

It is to be regretted that these books are so costly as to be out of the reach of most of us; but they can be seen to advantage in the library of the South Kensington Museum.

Mr. Hamerton's "Drawing and Engraving, a Brief Exposition of Technical Principles and Practice" (London: Adam & Charles Black, 1892), and "The Photographic Reproduction of Drawings," by Col. J. Waterhouse (London: Kegan, Paul & Co., 1890), are both portable and useful books, full of technical information. Sir Henry Trueman Wood's "Modern Methods of Illustrating Books" is also an excellent little manual, but its date is 1886.



EDMOND FREMY.

## EDMOND FREMY.

FRENCH science has just lost one of its most worthy representatives in the person of an illustrious master, Edmond Fremy, who died on the 3d of February in his apartments at the Museum of Natural History, after a long illness, at the age of eighty years. The career of this learned man was one of the longest, finest and best sustained that can be found among those of such men as have honored their country.

Fremy was born at Versailles on the 28th of February, 1814. The sciences had always been held in honor in his family, and he was reared with touching solicitude by his father, who was a man of much merit and a professor of chemistry at the School of Saint Cyr. After finishing his studies Fremy became preparator of the lectures of Gay Lussac at the Polytechnic School, at which, at this epoch, Pelouze was an assistant professor. He soon caused himself to be remarked by his ardor in work, by the qualities of his intelligence and by his rare experimental ability. Later on he succeeded, at the Polytechnic School and College of France, Pelouze, who had become professor at these two establishments.

The young professor did not stop here; he replaced Gay Lussac for some time at the Museum of Natural History, and finally succeeded his two masters in 1843 and 1850. Before occupying the chairs of chemistry of the Polytechnic School and the Museum, he had delivered courses of lectures at the Central School and School of Commerce. His diction was clear and his elocution easy. He had, nevertheless, preserved the somewhat pompous form of discourse that was in favor at the beginning of the century. Despite these multiple blemishes of the professorship, he devoted himself to numerous researches in his laboratory. His labors were generally crowned with success, and his important discourses, which we shall enumerate further along, soon placed him in the rank of the most distinguished chemists of our epoch. In 1857 he succeeded Baron Thenard as a member of the Academy of Sciences. In 1879 he succeeded Chevreul in the direction of the Museum. It was while he was at the head of this establishment that the grand gallery was inaugurated and that the great laboratories of Buffon Street were opened.

Decorated with the cross of the Legion of Honor in 1844, the eminent scientist was promoted as officer in 1862 and commander in 1878.

Fremy leaves behind him a rich collection of works and new applications. His first memoirs date back to 1835. They concern the precious metals, gold and silver, and the rare and little known metals of the platinum group. His researches upon ozone, in collaboration with Becquerel, upon the ammoniacal bases of cobalt, upon the fluorides and upon the syntheses of the crystallized minerals successively attracted attention, and at times contributed to the progress of the industrial arts.

We owe to Fremy important works in organic chemistry. He added new facts to the history or the productions of fatty acids and of saponification. He studied the balsams, resins, gums and pectic substances, and was enabled to throw a bright light upon every subject whose study he undertook. He devoted himself particularly to the study of the immediate principles contained in plants. Contrary to the opinion of Payen, he showed that the cellulose genus, so to speak, comprises several different species, and he characterized vasculite, the origin of the ulmic substances. He likewise extended his investigations to the products derived from animals. We are indebted to him for an extended work upon the composition of bones.

Fremy did not confine himself to the study of pure science, but took part in great exploitations.

Director of the Saint Gobain works, he was able to introduce improvements into the manufacture of soda, sulphuric acid, glass, and of the products that are the basis of modern industries. He devoted himself, again, to numerous researches upon steel, cast iron and gun metal, and he discovered an alloy of iron and steel of remarkable tenacity. Toward the end of his life our chemist, with Mr. Verneuil, one of his pupils, published the results of his labors upon the artificial production of rubies. The numerous specimens of crystals that he obtained by synthesis were exhibited by him in one of the rooms of his apartments at the Museum. This was his last work.

We have just seen that Fremy has rendered the greatest services to applied chemistry, but it must not be forgotten that during his long career he likewise played an important *role* in experimental instruction.

From the time of his entering the Museum he opened his laboratory freely to all young chemists who presented themselves to him. Several of our scientific celebrities are included among his pupils. Cloez, who died a few years ago while examiner at the Polytechnic School, was one of Fremy's pupils. Mr. Deherain, a member of the Academy of Sciences, entered Fremy's laboratory in 1850, and remained there for several years. Later on, the experimental method of teaching chemistry had become very greatly developed when Fremy was able to open to it the vast laboratories of Buffon Street. Mr. Moissan, member of the Academy of Sciences, made his *debut* in the new laboratories before becoming a pupil to Mr. Deherain. Messrs. Etard, Verneuil and Ogier experimented in Buffon Street under the immediate direction of Mr. Terreil, who was Mr. Fremy's assistant for forty years.

Fremy's publications were very numerous and of the greatest utility. The *Traité de Chimie*, in six large volumes, by Pelouze and Fremy, long remained the fundamental work of classic instruction. In 1881 Fremy began the publication of a vast encyclopedia of chemistry, which was done under his direction, with the collaboration of the most competent scientists, and which is now finished.

Fremy published more than a hundred memoirs in the *Comptes Rendus* of the Academy of Sciences and in the *Annales de Chimie*.

Among his works we may mention, in addition, Lectures on Oxygen and Ozone, Gun Metal, and his last and well edited work on the Synthesis of the Ruby.

After Fremy, having already reached an advanced age, became incapable of continuing his functions as director of the Museum, he was put on the retired list. He felt extremely annoyed at this, and so much the more so in that the administration, assuredly ill-inspired, suppressed his chair and closed his laboratory. Dating from this time he, who had been up till then very sociable and sprightly and a brilliant conversationalist, became morose and taciturn. He lived in solitude up to the time of his death.

The work that he leaves behind him will not perish. He was a worthy man, who, during his long existence, disseminated useful discoveries and fecund labors, and his memory is worthy of our gratitude.—*La Nature.*

## THE PRESERVATION OF INFUSIONS.*

By EDMUND WHITE, B.Sc.

THE preservation of infusions, in common with other organic fluids, is dependent upon the exclusion of various organisms—chiefly moulds and bacteria. The preservative action of alcohol is due to its inhibitory action on the life processes of any organisms which may gain access; that is to say, alcohol is an antiseptic. The addition of alcohol or other antiseptic is attended with disadvantages so obvious as to need no mention here. It has always seemed to me that there was ample room for the application in pharmacy of the comparatively recent results of biological research. Thus it is a simple matter for the bacteriologist to preserve for all time his culture media, which, under ordinary conditions, rapidly putrefy. It is also a well established fact that an organic fluid once sterilized will remain unchanged if protected from the access of fresh organisms. The result of some experiments in this direction I now publish.

### *Preservation of Infusions Without the Addition of Antiseptics.*

In November, 1892, some infusion of gentian was made. An 8 oz. flask (A), containing 2 oz. distilled water, was then boiled for ten minutes, and some of the infusion strained into it after turning out the residual water. The neck was instantly plugged with sterilized cotton wool and the flask set aside. The infusion remained good for five weeks, and then some filamentous mould appeared. Immediately this was observed, the contents of the flask were raised to the boiling point and the mould destroyed. The infusion has remained unchanged ever since.

Another flask (B) was filled at the same time, November, 1892. It was thoroughly washed, some fresh infusion of gentian placed in it, the neck being plugged with cotton wool. After bringing the infusion to the boiling point and continuing the ebullition one minute, the flask was set aside, the cotton wool plug being heated in the flame till it singed slightly, in order to completely sterilize it. This infusion has remained absolutely unchanged for fifteen months, and has been examined for bacteria at intervals, with negative results.

Some infusion of ergot was made on January 29 last, the flask (C) being previously sterilized by boiling water in it immediately before pouring in the infusion. The contents are therefore seventeen days old, and have shown no sign of decomposition. A further quantity of infusion of ergot was made on January 29 last, but the infusion was boiled after introduction to the flask (D). This also remains unchanged.

Other flasks (E and F) contain infusion of buchu, the manipulation being the same as for flasks C and D respectively. The results are the same also.

Infusion of calumba made twelve days ago has been sterilized by filtration through a kieselguhr block of the Berkefeld Filter Company, and received directly into a flask (G) which had been just previously sterilized by boiling distilled water in it. The filtering block and its connections were boiled in water just before filtration, the neck of the flask being afterward plugged with sterilized cotton wool as in the other experiments. Some infusion of calumba was filtered in the same way and at the same time as that in G, into a flask (H) cleaned in the ordinary way only, and not sterilized by boiling water. The result is entirely different. After three days a faint turbidity appeared, which has continually increased, until now the infusion is absolutely putrid. The difference between the two experiments, G and H, was that the flask, G, was sterilized and H was simply cleaned under the tap.

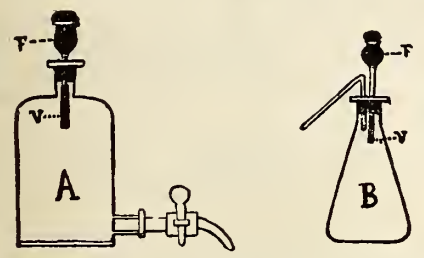
These experiments show, I think, that the pharmacist may do a great deal toward the abolition of the so-called concentrated infusion. For instance, a quantity of freshly made infusion may be filled into flasks of convenient size, the flasks having been previously sterilized in the manner described, and the necks immediately plugged with cotton wool recently heated to 120°–150° C., say in an ordinary kitchen oven. It would probably be safer to raise the contents of the flasks to the boiling point before putting them aside, but unless they are required to be kept a long period this will be unnecessary. Any loss of aroma through the cotton wool plug may easily be prevented by placing a rubber cap, such as is used for bacteriological purposes, over the mouth of the flask.

The method by filtration through kieselguhr gives more trouble, but it enables one to present infusion of calumba or quassia in exactly the condition required by the Pharmacopœia, the application of heat being quite unnecessary if the filtration be properly carried out.

In place of preserving the infusion in a series of small

* Paper read before the Chemists' Assistants' Association.—*Pharm. Jour.*

flasks, one larger one may be employed, like the one illustrated. It has a well-fitting rubber stopper pierced with two holes, through one of which passes a thistle funnel plugged with sterilized cotton wool, and terminating just inside the stopper. The end is constricted to a narrow orifice to prevent the infusion wetting the wool when the flask is turned up, or a simple valve made from rubber tubing may be attached. The other hole receives a tube bent downward and six or eight inches long, terminating likewise just inside the stopper. A few ounces of water is first placed in the flask and boiled for ten minutes. The residual water is then turned out and replaced by the fresh infusion. Whether it is necessary to raise the contents to the boiling point after introduction will depend partly on the nature of the infusion, and still more on the care which has been exercised in preparing the flask and infusion. When any of the infusion is required it is simply necessary to turn up the flask and let it run out of the bent delivery tube, air flowing into the flask, to replace the liquid poured out, through the cotton wool plug in the thistle funnel. The entrance of organisms is thus prevented. For extra safety the open end of the delivery tube when not in use may be closed with a piece of rubber tubing and a clip. I have several times filled a flask of this kind with some infusion and poured out a few ounces daily, just as if it were required for dispensing purposes. The infusion has always remained good till the end.




VESSELS FOR STORING INFUSIONS.

A, stock bottle; B, flask for dispensing purposes; V, rubber valve; F, thistle funnel, filled with cotton wool.

I have followed a similar plan in the case of infusions —say buchu—where about two gallons is required every week. A bottle provided with a tubulure at the bottom, through which passes a glass tap or tube and clip, and holding a little over two gallons, is thoroughly cleansed and then rinsed several times with freshly boiled and cooled distilled water. The infusion is placed in the bottle and the mouth closed by a good cork, through which a thistle funnel, plugged with cotton wool, passes, in order to admit air as the contents are drawn off. It is by this means easy to keep an infusion from two to four weeks, which would go bad in as many days if stored without these precautions.

The conclusions to which these experiments lead are as follows:

1. An infusion prepared with boiling water is sterile when perfectly fresh, if care be taken to avoid unnecessary exposure.

2. The infusion so prepared may be kept sterile in a flask in which water has been recently boiled.

3. Raising the contents of the flask to the boiling point after plugging renders their preservation more certain.

4. Cold infusions may be sterilized by filtration through kieselguhr blocks.

*Preservation of Infusions by the Addition of Antiseptics.*

The addition of antiseptics to ordinary infusions is, of course, inadmissible, but the so-called concentrated infusions usually contain 15 or 20 per cent. of rectified spirit. The two chief objections to this addition are (1) the cost of the alcohol, and (2) the alteration in physical character which is produced by its addition. In several discussions on the preservation of infusions and fluid extracts, chloroform has been mentioned, but generally dismissed as altogether without the pale of discussion. This, I venture to think, is a great mistake. For instance, I produce a concentrated infusion of senega, preserved by the addition of 1 in 400 by volume of chloroform. Fluid extracts may be preserved equally well without the use of alcohol. One fluid drachm contains, therefore, one-seventh of a minim of chloroform, a quantity surely too small for any objection to be raised to its presence. If the infusion contained alcohol as a preservative, the same dose would probably be equal to 15 minims of rectified spirit. The diluted chloroformed infusion would contain 1 in 3,200 of chloroform, equal to a half drachm of chloroform water in one ounce. This amount of chloroform has a very slight taste, even in plain water, and in presence of other flavors becomes practically indistinguishable. Moreover, the addition of 1 in 400 of chloroform produces no precipitate and no change in the physical appearance of the fluid, such as follows the addition of 15 or 20 per cent. of rectified spirit. The relative cost of chloroform and rectified spirit, when used in the proportions I have mentioned, is about 1 to 80, if 20 per cent. of rectified spirit be used. In using chloroform the greatest care must be taken to prevent any contamination or incipient decomposition before the addition of the preservative to the finished product. Where admissible, it is a good plan to raise the finished fluid to the boiling point in order to sterilize it, and then add the chloroform as soon as it is cold.

My own experience has proved that chloroform might advantageously replace alcohol as a preservative in many pharmaceutical preparations.

## FRESH WATER FROM SALT WATER.

By A. NORMANDY, Essex, England.

THIS is an apparatus for producing fresh from salt water by a system of multiple evaporation. Steam is produced from salt water in an ordinary boiler, and led into a condensing chamber surrounded by cold salt water, which is evaporated by taking up heat from the condensing steam. The vapor from this chamber is treated similarly in a second vessel, and the result again in a third; the water vapor from the last operation is finally condensed in an ordinary condenser. The condensed fluids from all the chambers are run together under certain regulations, and the supply of salt water to each chamber and to the boiler is regulated by means of floats, which are governed by the effluent condensed water from each casing; the supply to each casing being regulated by the water issuing from the next condensing vessel.

ANALYSES OF NATURAL GAS.

| CONSTITUENTS. | Freedonia, N. Y. | Sheffield, Warren County, Pa. | Kane, McKean County, Pa. | Wilcox, McKean County, Pa. | Speechly, near Oil City, Pa. | Lyons Run, Murrysville, Pa. | Raccoon Creek, Pa. | Houston, near Cannonsburg, Pa. | Murrysville, Pa. | Pittsburg Exhibition Grounds, Pa. | Cleveland, O. | Creighton, Pa. | Painter & Co.'s Well, Pittsburg, Pa. | Baden, Pa. | Kokomo, Ind. | Allegheny City Salt Well | Vancouver, British Columbia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Nitrogen | 9·54 | 9·06 | 9·79 | 9·41 | 4·51 | 2·02 | 9·91 | 15·30 | 4·40 | 7·30 | 6·30 | 0 | 0·70 | 12·32 | 6·00 | 7·10 | 6·30 |
| Carbon dioxide | 0·41 | 0·30 | 0·20 | 0·21 | 0·05 | 0·28 | trace | 0·44 | 0·20 | 0·52 | 0·20 | 3·64 | 0·40 | 0·41 | 0·40 | 0·30 | 0·14 |
| Hydrogen | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ammonia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oxygen | trace | trace | trace | trace | trace | trace | trace | trace | trace | trace | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sulphureted Hydrogen | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Paraffins | 90·05 | 90·64 | 90·01 | 90·38 | 95·44 | 97·70 | 90·09 | 84·26 | 95·40 | 92·18 | 93·50 | 96·36 | 98·90 | 87·27 | 93·60 | 92·60 | 93·56 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| The paraffins contained in these gas samples have the following composition by weight | | | | | | | | | | | | | | | | | |
| Carbon | 78·14 | 76·69 | 76·77 | 76·52 | 77·11 | 74·96 | 76·42 | 76·68 | 75·15 | 75·40 | 76·40 | 75·80 | 75·51 | 76·48 | 75·40 | 75·44 | 75·23 |
| Hydrogen | 21·86 | 23·31 | 23·23 | 23·48 | 22·89 | 25·04 | 23·58 | 23·32 | 24·85 | 24·60 | 23·60 | 24·20 | 24·49 | 23·52 | 24·60 | 24·56 | 24·77 |

Nos. 1, 2, 3, 4, 5, 6, 7, 8, 14 are cited from *Report of Geol. Survey of Penna., 1886*. Tests were made at the wells in all cases excepting Kokomo and Vancouver. In the case of these 2 localities samples were very carefully taken and forwarded by Mr. E. C. Somers (Kokomo) and Mr. C. F. Hutchings (Vancouver). (All the analyses were by F. C. P.)

## CHEMICAL PROPERTIES OF GASES.*

By FRANCIS C. PHILLIPS.

### (I) COMPOSITION OF NATURAL GAS.

THE gas used in the following trials was that supplied to Allegheny by the Allegheny Heating Company, and is the product of wells scattered over a considerable gas-producing area. It may be said to represent the average composition of an enormous volume of gas. No important differences have been observed during the period from 1886 to 1892 in the heating or illuminating power of the gas as supplied to the city, except that the odor of petroleum (*i. e.*, of higher paraffins) has been occasionally stronger.

Tests have also been made of gas from various localities in Pennsylvania, New York and Indiana, and Vancouver, British America, and also at Cleveland, O.

In all cases where possible the tests were made at the wells. When this could not be done, it was necessary to use samples brought in glass vessels to the laboratory. In such cases, the samples were examined for oxygen before being subjected to the tests. As a leak in a sample vessel invariably causes an interchange of air and gas, so that air enters in proportion as an escape of gas occurs, much dependence is to be placed on the presence or absence of air in a gas sample as a criterion of its purity.

*Hydrogen.*—Hydrogen is almost always mentioned in the published analyses of natural gas. I have made the following chemical tests: The natural gas, as supplied to Allegheny by the Allegheny Heating Company, was caused to flow through a solution of palladium chloride for periods varying from 10 days to 3 months; 500 feet have been used in a single experiment. Similar tests have been repeated at various times between January, 1886, and May, 1892; but in no case was a trace of precipitation observed in the palladium chloride solution. Natural gas was found likewise to be without action upon solutions of platinum chloride and ammoniacal silver nitrate. A stream of natural gas has been passed through dry pure palladium chloride. This extremely delicate test has failed to show the presence of hydrogen even in traces, although tried repeatedly during the period from January, 1886, until May, 1892. As already stated, the results of my study of gas reactions show that palladium chloride produces very different effects according as it is used dry or in solution. Palladium chloride dry is reduced promptly by dry hydrogen when the gas is used in a free state.

The same salt in solution is slowly and incompletely reduced by hydrogen, although it is rapidly reduced by olefines and carbon monoxide. Similar tests with palladium chloride, both dry and in solution, made at the wells, in the cases of all the localities mentioned in the Table No. 1 from 1 to 14, have led to similar results. Natural gas from Vancouver and from Kokomo, Ind., could not be tested at the wells. Tests made in the laboratory, of the samples received from those localities, gave the same negative results.

Another method of testing for hydrogen has been employed. As is well known, a jet of hydrogen is immediately ignited by platinum asbestos. Natural gas under similar conditions is not ignited, even when the gas jet and the platinum sponge are mounted in an oven kept at a temperature approaching 300°. In order to ascertain the effects of different proportions of hydrogen and natural gas, a gasometer containing the gas mixture to be tried was connected with a jet in form of a drawn-out glass tube, above which some platinum asbestos was fixed. The gas pressure could be so regulated as to produce a pointed flame 1 in. long. By momentarily shutting off the gas by pinching the hose, the flame could be extinguished, and the gas, being turned on again, played against the platinum asbestos. The length of the flame when the gas stream from the jet was ignited was therefore a measure of the gas flow. The gas was ignited by the platinum asbestos or not, according as the proportion of hydrogen in the natural gas was greater or less. The ignition of the gas was also dependent upon the temperature of the oven in which the jet and the platinum asbestos were fixed.

Mixtures of hydrogen and natural gas produced glowing of the platinum and ignition of the gas at the following temperatures, when the experiment was made in a large iron oven whose temperature could be readily measured. The gas pressure was the same in all trials.

| *Proportion of Hydrogen and Natural Gas.* | | *Temperatures of the Oven at which the Gas Inflames as it Strikes the Platinum Asbestos.* |
|---|---|---|
| Natural gas | 95 | 40–50° |
| Hydrogen | 5 | |
| Natural gas | 97·5 | 80–90° |
| Hydrogen | 2·5 | |
| Natural gas | 99 | 180° |
| Hydrogen | 1 | |
| Natural gas | 99·5 | 210–220° |
| Hydrogen | 0·5 | |
| Natural gas | 99·75 | 270° |
| Hydrogen | 0·25 | |
| Pure natural gas | | 270–290 |

The observed temperatures naturally vary with the pressure, size of jet, etc., but trials with different pressures showed greater constancy than could be anticipated from a method so rough in appearance. The results corroborate those obtained by the more delicate tests. Experiments have also be tried with mixtures of air and natural gas which were exposed to palladium asbestos contained in glass tubes heated in the iron oven described under "Oxidation Temperatures of Hydrocarbons." It has been repeatedly shown that, under such conditions, moisture is only produced at temperatures approaching or higher than the melting point of cadmium iodide.

The absence of free hydrogen has interfered with the use of natural gas in gas engines. The prompt, sharp explosion of coal gas, so necessary for these motors, cannot be produced in the case of natural gas, which requires a higher temperature for its ignition, and explodes with less suddenness, owing to the absence of hydrogen.

The electrical devices for the igniting of coal gas jets in dwellings by the spark of an induction coil have not been so successful where natural gas is used, owing to the higher temperature of ignition of a gas consisting of paraffins and containing no hydrogen. In laboratories where natural gas is the fuel, chemists have experienced the inconvenience that Bunsen burners and blast lamps do not produce the high temperature easily obtained when coal gas is used. Ordinary glass combustion tubing cannot be softened by the employment of natural gas in a Berzelius blast lamp.

A coal gas flame owes its steadiness and stiffness to the hydrogen which the gas contains. Natural gas flames are much less steady and more easily extinguished by air currents.

During May, 1892, a change occurred in the composition of the natural gas supplied to Allegheny City. The gas since that time and up to November, 1892, has been found to contain hydrocarbons which reduce dry palladium chloride. These hydrocarbons are removed completely by digestion with fuming sulphuric acid, so that the gas after this treatment does not reduce palladium chloride. The nature of these hydrocarbons I have been unable yet to determine.

*Olefines.*—Palladium chloride, iridium chloride, cerium dioxide in sulphuric acid, osmic acid, all remain unchanged by natural gas cold or at 100°. Potassium permanganate is attacked with extreme slowness.

Bromine water has been repeatedly tried. The solution was in some cases cooled by ice to check evaporation of the bromine and in others the bromine was added slowly, drop by drop, to compensate for its evaporation. In no case were any oily drops produced. Prof. Sadtler, of Philadelphia, has in one instance obtained a considerable amount of heavy oil by the action of bromide on natural gas.

My experiments seem to prove the absence of ethylene, propylene, isobutylene and trimethylene from the gas supplied to Allegheny. The same is true of gas from the localities mentioned in the table from Nos. 1 to 17. Tests could not be made at the wells in the case of gas from Kokomo, Ind., and Vancouver, British Columbia; but samples brought to the laboratory gave similar results.

The very low illuminating power of natural gas of Western Pennsylvania is a further evidence of the absence of olefines which, as well known, are remarkable for the brilliancy of the light which they produce. By the kindness of Mr. J. W. Patterson, Gas Inspector of Allegheny County, I am able to give the following data as to illuminating power.

The gas supplied to Pittsburg by the mains of the Philadelphia Company, November 30, 1892, possessed an illuminating power equal to $10\frac{8.4}{10.0}$ candles per 5 feet of gas burnt per hour (mean of 10 determinations).

On the same date the illuminating power of the natural gas supplied by the People's Natural Gas and Pipeage Company was $10\frac{7.7}{10.0}$ candles.

Mr. Patterson's tests were made with a 36 hole Argand burner, having a chimney 7 in. long.

*Acetylene and Allylene.*—Palladium chloride solution is unchanged, as already stated. Cerium dioxide, mer-

* Read before the American Philosophical Society, March 17, 1893.—*Light, Heat and Power.*

curic chloride, gold chloride, silver nitrate, ammoniacal cuprous chloride and osmic acid are all unchanged. Hence in the gas I have tested, it may he said that no hydrocarbons of the acetylene series occurred.

I have found no reference to acetylenes in any published analyses to which I have had access.

*Carbonic Oxide.*—Carhonic oxide is nearly always stated to occur in the published analyses of natural gas.

In my experiments, palladium chloride, gold chloride, silver nitrate in ammonia, iridium chloride, rhodium chloride, osmic acid, all used in solution, were unchanged.

Experiments have been made with Allegheny City natural gas in the following way: Gas has heen caused to buhble for five weeks through ammoniacal cuprous chloride solution. This solution was then largely diluted with water and boiled. The gases expelled were collected and tested hy palladium chloride solution; but no carbon monoxide was found. It is true that, since the absorption of carbon monoxide in cuprous chloride has been shown to be a case of mechanical solution rather than chemical union, and that the ahsorbed CO can be expelled by a stream of other gases, the use of cuprous chloride for the absorption and recognition of carbon monoxide cannot be implicitly depended on. Still, the direct tests above named lead me to the conclusion that no carbon monoxide occurs in our natural gas.

*Paraffins.*—That the lower paraffins occur in natural gas needs no proof. Methane is the chief constituent. Small quantities of higher paraffins are usually present.

*Sulphur Compounds.*—Pennsylvania natural gas does not contain recognizable quantities of either COS, $CH_3SH$ or $(CH_3)_2S$. Toward the western boundary of the State it is possible that minute traces of sulphureted hydrogen occur. The quantities of all such compounds are far too small to allow of their being easily identified, even in the case of large volumes of gas. The extreme delicacy of the reaction of methyl mercaptan toward paliadium chloride would render it possible to detect exceedingly minute quantities of this compound, should it occur.

I have not had an opportunity to test the gas from the Western Ohio territory, which is said to contain sulphur compounds in considerable quantity.

*Nitrogen.*—Natural gas, dried by calcium chloride and phosphorus pentoxide, was passed over strongly heated magnesium powder. The magnesium was partly converted into a nitrite, easily recognized by its reaction toward moisture, yielding ammonia in considerable amount.

Repeated trials have been made of natural gas in the following way:

A measured volume of gas was passed over ignited oxide of copper contained in a porcelain tube, the entire apparatus having been previously filled with pure carbon dioxide, which was caused to flow in a continuous stream for several hours in order to expel all traces of air. The escaping gas was collected in a eudiometer over mercury and the carbon dioxide absorbed by soda. There was left invariably a residue of gas unabsorhed by the soda and having no action upon palladium chloride solution. This residual gas was evidently nitrogen. (See Tahle of Analyses.) In the gas found in an artesian boring at Middlesborough, England, nitrogen was found in large proportion. (See Table of Analyses.)

*Oxygen.*—By the use of pyrogallol and soda, and by the oxidation of manganous hydrate in water, I have frequently been ahle to detect traces of oxygen, although on other occasions no oxygen could be found. It has only been recognized when the gas had buhbled continuously for many hours or days through the reagent. It cannot be said that oxygen is a constant constituent, although it does unquestionably occur in much of natural gas in minute traces.

*Carbon Dioxide.*—Carbon dioxide is present in all natural gas, as is easily proved by its action upon lime water.

*Ammonia.*—In the case of a gas well near Canonsburg, the following result was ohtained: Gas was caused to bubble directly from the main at the well through water for several hours. On applying Nestler's reagent to the water, a feeble reaction was obtained. Ammonia was not found elsewhere in the trials I have made.

Mr. S. A. Ford, of the Edgar Thomson Steel Works, reports a very interesting case where masses of solid ammonium carbonate were blown out from a gas well by the pressure of the gas.

Natural gas appears to consist chiefly of methane, with traces of higher hydrocarbons of the paraffin series. Nitrogen is prohahly always present, together with a little carhon dioxide. The absence of free hydrogen, of olefines and of carbon monoxide, is, I believe, clearly shown in the case of the natural gas I have examined.

If natural gas as found in the well of any one gas region is derived from one vast subterranean reservoir, approximate uniformity in composition should be looked for. It is often noticed, however, that gas from adjacent wells possesses a different odor.

A carbon dioxide determination was made in the case of samples of gas from six wells near Tarentum, Pa. These wells were situated nearly on a straight line less than a mile in length. The samples were all taken within an interval of three hours.

The determinations were made by a 7 per cent. soda solution in an eudiometer over mercury.

| Well. | Carbon Dioxide Per Cent. |
|---|---|
| No. 1 | 0·42 |
| No. 2 | 1·25 |
| No. 3 | 0·25 |
| No. 4 | 1·47 |
| No. 5 | 1·28 |
| No. 6 | 1·28 |

The differences in the proportion of carbon dioxide, a constituent determinable with great precision, would be difficult to explain if the gas flowing from these different wells is derived from one subterranean reservoir.

### (II) QUANTITATIVE ANALYSIS OF NATURAL GAS.

It is not possible to determine the proportion of the individual paraffins in a gas mixture by the Bunsen method of explosion of oxygen unless it can he positively asserted that only 2 paraffins occur. This may be readily shown by an example. If a mixture of one volume each of marsh gas, ethane and propane is burnt, the volumes of oxygen required, carbon dioxide and steam produced will be as follows:

| | Oxygen Required vols. | $CO_2$ vols. | $H_2O$ Vapor vols. |
|---|---|---|---|
| 1 vol. methane | 2 | 1 | 2 |
| 1 vol. ethane | 3½ | 2 | 3 |
| 1 vol. propane | 5 | 3 | 4 |
| | 10½ | 6 | 9 |

Three volumes of ethane require for combustion 10½ volumes of oxygen, and yield 6 volumes $CO_2$, and 9 volumes of steam.

Hence a mixture of 3 gaseous paraffins could not be distinguished, in the case of a volumetric analysis, from the intermediate paraffin. Moreover, the heat of combustion of 3 volumes of the intermediate paraffin is almost exactly equal to that of a mixture of one volume each of the three.

From the fact last stated it follows that, as regards the calorific value of a mixture of paraffins, an exact determination of the character of the individual paraffins is not required.

A saving of time, the possibility of using a larger volume of gas, the avoidance of a volumetric determination of water vapor, are some of the advantages gained by a combustion over copper oxide.

The application of gravimetric methods for the examination of gas is not new. Winkler ("Handbook of Technical Gas Analysis," p. 87) has described such a process for the analysis of mine gas.

*Description of Method.*—The process employed was, with some slight modifications, the same as described in the "Annual Report of the Geological Survey of Pennsylvania," for 1886.

Glass cylinders having stop cocks at both ends, accurately calibrated by mercury, and of 300–400 cubic centimeters capacity, were filled with natural gas. Where possible, this was done at the well. Before filling with gas, finely drawn out threads of glacial phosphoric acid were inserted through the stop cock into the vessel. After 24 hours the gas sample could be considered dry.

Glacial phosphoric acid, on softening in the flame, may be readily drawn out like glass into rods of almost hairlike fineness. The quantity required was not sufficient to cause error in the gas measurements, inasmuch as the gas, as it flows from the wells, is in most instances remarkably dry.

| Mixture of Methane Vols. | Mixture of Ethane Vols. | Carbon Per Cent. | Hydrogen Per Cent. |
|---|---|---|---|
| 1 | 1 | 78·22 | 21·78 |
| 3 | 2 | 77·73 | 22·27 |
| 2 | 1 | 77·38 | 22·62 |
| 5 | 2 | 77·11 | 22·89 |
| 3 | 1 | 76·89 | 23·11 |
| 7 | 2 | 76·70 | 23·30 |
| 4 | 1 | 76·56 | 23·44 |
| 5 | 1 | 76·30 | 23·70 |
| 6 | 1 | 76·15 | 23·86 |
| 9 | 1 | 75·82 | 24·18 |

From a gravimetric analysis of natural gas, it is easy to determine the relative proportions by weight of carbon and hydrogen in unit volume, and from these the composition may be stated volumetrically in terms of ethane and methane, by the use of the preceding table, and with a fair approximation to the truth.

It is probable that minute quantities of propane and perhaps higher paraffins occur, but these cannot be identified. The nitrogen and carbon dioxide being determined, the volume of $CH_4 + C_2H_6 + C_3H_8 + \ldots$ is obtained as a difference. The error involved in such a method may then be exactly defined as follows:

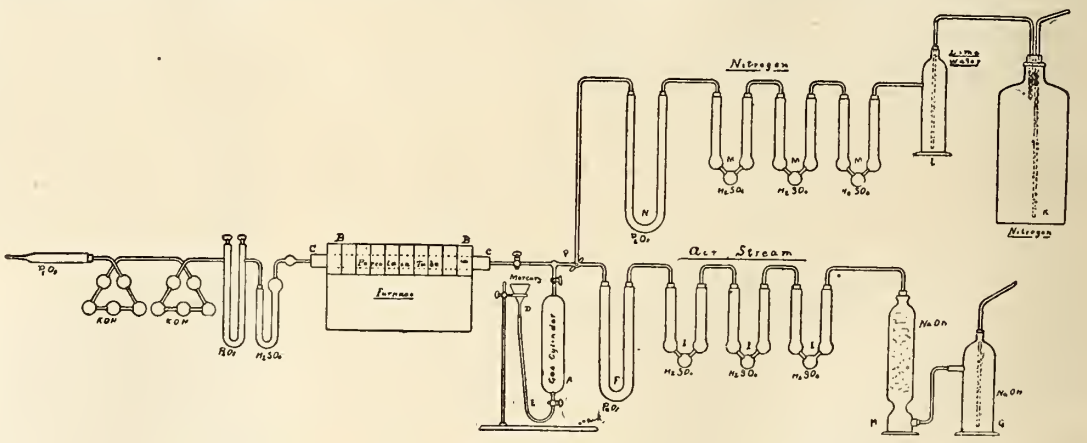
The hydrocarbons may consist of methane with traces of propane or of methane with ethane or butane, but the analysis will he stated volumetrically in terms of methane and ethane only.

As regards the question of fuel value, I have endeavored to show (see "Report of Geological Survey of Pennsylvania," for 1886) that the above method will give closely approximate results when certain factors relating to available heat of combustion of paraffins are used.

The gravimetric method affords at the same time a means of control, for it is not only true that in a given volume of a particular paraffin, or of a mixture of paraffins, the hydrogen and carbon will occur in definite quantity, but the ratio $\frac{C}{H}$ is a constant and will be greater as the proportion of higher to lower paraffins is greater.

These considerations will serve to show the limits of accuracy of the method.

Nitrogen was determined by passing a measured volume (100 cubic centimeters) over ignited copper oxide contained in a porcelain tuhe, and then into a eudiometer containing soda solution. By means of a stream of carbon dioxide continued for several hours,




APPARATUS FOR QUANTITATIVE ANALYSIS OF NATURAL GAS.

the air was expelled from the apparatus previous to the combustion of the gas. In presence of large excess of carbon dioxide. combustion by copper oxide is greatly retarded, and the process must he conducted very slowly to effect complete oxidation.

Oxygen, as already stated, occurred in too small proportion to allow of a quantitative determination.

Carhon dioxide was determined by soda solution in a eudiometer over a mercury trough.

*(To be continued.)*

| Paraffins. | Carbon Per Cent. | Hydrogen Per Cent. |
|---|---|---|
| Methane | 74·97 | 25·03 |
| Ethane | 79·96 | 20·04 |
| Propane | 81·78 | 18·22 |
| Butane | 82·72 | 16·28 |

In the following table the calculated composition by weight of various mixtures of methane and ethane is given (the atomic weight of carbon being 11·97):

## DIFFRACTION.

At a recent meeting of the Physical Society, London, Mr. W. B. Croft read a paper on some observations in diffraction, and exhibited a large number of photographs of diffraction figures obtained under different conditions. The first series exhibited, says *Nature*, related to diffraction from parallel light (diffraction of Fraunhofer and Schwerd), and were obtained by placing various combinations of thin circular lines of light on a dark glass plate before the object glass of a telescope focused on a star. Spectral images of the star are formed by interference from the edges of the lines, thus giving diffraction patterns whose form depends on the shape of the aperture employed.

The next series illustrated diffraction in shadow (Fresnel's diffraction), and were produced by condensing light on a minute pinhole, and placing the object between the hole and a microscope eyepiece. Beyond the eyepiece the camera used for photographing the phenomena was placed. Permanent records of remarkably good diffraction figures were obtained in this way, both of the combinations of circles above mentioned and of various other objects and geometrical forms. After showing geometrically that diffraction bands from narrow obstacles and openings were wider than those from broader ones, the author explained the conditions necessary for making the bands visible, and pointed out the distinction between internal and external bands.

Prominent among the photographs were several showing "Arago's white spot" at the middle of a shadow, and, in particular, this well-known phenomenon was shown as produced by so large an object as a threepenny piece. Speaking of diffraction in a microscope, the author said little doubt need exist as to

whether an image represented the real object or a diffraction modification thereof, for the latter were usually of a more misty and complicated character. Departing somewhat from the subject of diffraction, an excellent photograph of conically refracted pencils was shown, consisting of circular lines of light produced by passing light from pinholes through a crystal of arragonite. Dr. Johnstone Stoney thought the obtaining of permanent records of diffraction phenomena of great importance, and was particularly interested in the photograph showing conical refraction. Prof. S. P. Thompson said he had never seen diffraction effects exhibited to an audience so well before. He had noticed that in several of the photographs Arago's spot was unintentionally shown to perfection in the shadow of dust particles. The president greatly appreciated the fact that the conical refraction photograph had been exhibited for the first time before the Physical Society.

## BRAIN AND MUSCLE.*

By Dr. WILLIAM A. HAMMOND.

IT was with great pleasure that I accepted the kind invitation of the president of your Alumni Association and the founder of this course of lectures, Gen. Butterfield, to address you on the important subject of the relations of physical exercise to the mind and body in some of the prominent occupations of the active man. It is not to be expected that I shall enter at length into the consideration of the anatomy, chemistry, and physiology of the subject; but there are a few prominent points in these connections which it is essential should be understood in order that you may fully appreciate the views which are to follow. For, though you may already have a general idea of the matters to which I refer, it will not, I am sure, be time thrown away if I endeavor to bring them specifically to your attention on the present occasion.

In order that a person may have the capacity for physical exercise, he must possess three kinds of anatomical organs—nerve centers to provide the force by which the muscles are to be made to contract, nerves to transmit this force, and muscles, by means of which the force is manifested in the movements of the body and limbs. All these organs, however, would be useless unless there is the force, to which I have referred, to put them in action, and this force is the mind. And by mind we are to understand, not only the force that comes from the brain, but that also which is evolved from other parts of the nervous apparatus, the spinal cord and certain collections of gray nerve tissue called ganglia, found in various parts of the body. Without this force the organs in question would be in about the situation of an engine without the steam required to set it in motion. The organism is complete, its cylinders, pistons, and valves are in order; but it is dead, for the force that makes it a thing of life is not there. Now this force in the animal body is produced by the action of what is called gray nerve substance. In the brain this is placed on the outside to the depth of about a twelfth of an inch, and is hence called the cortex; but in the spinal cord it is in the interior of the organ, extending its whole length, and being shaped something like a capital letter H. I used to say in my lectures to medical students that if I should ever be disposed to make for myself a god, I would select a piece of gray nerve tissue as the object of my adoration. For it is the most wonderful substance, so far as we know, in the whole universe, surpassing in its grandeur sun and moon and stars and everything else of which we have any knowledge. It is the substance that makes man what he is, that causes him to perceive, to experience emotions, to conceive ideas, to exert his will—in short, to evolve his mind. And though it is found in all animals, high and low, it is in none in such great quantity or in such a high state of elaboration as in that being who stands at the head of all animated nature.

But the gray nerve tissue forms but a small portion of the nerve substance of the brain and of the spinal cord. There is another which constitutes the greater part of both these organs, and this is the white substance. The nerves themselves consist entirely of this matter. It has nothing to do with the production of force. Its office is to receive impressions from without and to convey to the muscles and organs of the body the power by which their functions are performed. It places the gray substance with which it is in intimate contact in relation with the external world.

I have said that the brain is not the only organ which serves for the production of mind. If you have ever seen, as I have in the course of physiological investigations, a decapitated frog perform acts showing the possession of perception, intellect, and will, you would at once admit the correctness of my statement—a statement which is certainly not in accordance with the preconceived ideas of many of you, and which would possibly be called in question by some physiologists. If the side of such a frog be gently tickled with a straw, the foot of that side is at once used to push the straw away; if that foot be held so that it cannot be employed, the foot of the other side is brought into action to accomplish the purpose. If the animal be placed in a vessel of water, it swims almost as vigorously as if the brain were still in its proper place, and if it meets with an obstruction, it turns aside to avoid it, or if unsuccessful in the effort, ceases its swimming movements. All these efforts show intelligence and indicate that there are other sources of mind than the brain. I have seen a snake crawl to its hole, a distance of several feet, after its head had been cut off, showing that the knowledge it had acquired before mutilation was still present and available for the object in view. The tale of a turtle will vibrate if pinched for several months not only after the head of the animal is removed, but after the entire contents of the shell have been scooped out and made into soup for the delectation of a London alderman or a New York epicure. And in *The New York Sun* of a recent date I find an incident described which bears directly on the point under discussion. A sea turtle was captured by a party of gentlemen on the Gulf shore in Texas, and its head was cut off preparatory to the animal being cooked. Much, however, to the surprise of the party, the decapitated turtle endeavored to escape by making for the water. Several times it was turned around, but in every instance it discovered the direction in which the water lay and made efforts to reach it. The writer states that he has several times witnessed a repetition of the procedure, and calls attention to the fact that water snakes exhibit the like action when decapitated.

I call to mind how upon one occasion a rattlesnake behaved to a teamster who had cut off its head with a stroke of his whip lash. The snake remained coiled, and the man bent over it to examine the animal more closely. Suddenly the coil straightened, and the headless and bloody trunk struck the curious observer full in the forehead. The man fainted from the nervous shock, and the snake crawled away to hide under a sage bush.

These manifestations are not so striking in warm-blooded animals, but even in them they are not entirely absent. You have all probably seen a chicken, after its neck has been wrung, walk several steps in quite a determinate manner before falling and dying from loss of blood.

A man, however, without a head is not of much use, but this is mainly due to the fact that the act of decapitation necessarily involves the loss of such a large quantity of blood that the death of the whole body ensues almost at the very instant. Nevertheless, I can recall to your minds many examples in which while the brain, though present, is quiescent or otherwise engaged, actions are performed which can only be the result of some degree of mentality. Take for instance the fact (of which doubtless many of you have personal experience) that a young lady will engage her brain in conversation with her sweetheart while at the same time she performs a difficult piece of music on the piano. She cannot do this with a composition that she has not thoroughly learned, for then she requires all the mind that the brain and spinal cord can give her; but when the music is well mastered she can employ her brain with her young man and her spinal cord with her piano. You have all doubtless, while walking or reading, occupied your higher mental faculties with something very foreign to directing your steps in crossing streets or jumping gutters and turning corners until you reached your own doorsteps, or in paying attention to the novel you may be perusing or the abstruse volume on mathematics you are studying, and yet you have never made a mistake in your route or failed to turn over the leaves regularly as you reached the bottom of the pages without your having the slightest consciousness of what your legs have been doing in the one case or your hands in the other. No idea of the scenes that have been enacting before you, or of the incidents or problems of your books, has been formed. Your brain has been otherwise employed; your spinal cord has moved your legs and your hands.

The main point I wish to impress upon you in citing these facts is this—that there is a force that comes from the brain and that there is another, and a lower order of force, that comes mainly from the spinal cord. As a consequence there are two kinds of physical exercise—that to which the whole mind is given, and which is therefore active, spirited, determinate, conscious; and that into which the higher qualities of the mind do not enter, and which is, therefore, automatic, spiritless, and almost, if not entirely, merely mechanical. I simply mention these facts now in order to indicate the principles I desire to lay before you; but as they constitute the essential feature of my remarks, and are the basis of the advice I shall have to give you, I shall consider them at greater length when I have touched a little more fully upon some of the primary conditions associated with all physical exercise.

In order that force of any kind should be developed, matter of some description must undergo a change of form. To obtain steam and the force due to its expansion we ordinarily employ some highly carbonaceous substance, such as coal, wood or petroleum, by the combustion of which it is decomposed, heat is evolved, the water is raised in temperature, and steam is formed. To obtain the force known as galvanic electricity we can take a plate of carbon and one of zinc and immerse them in sulphuric acid diluted with water. The acid at once attacks the zinc, a new compound of sulphate of zinc is formed, the water is decomposed into its ultimate elements, and through this double action galvanism results and passes off by means of the attached conductors. Then it may in its turn decompose a solution of gold and gild a trinket, flash a telegraphic message to a distant part of the earth, aid the physician in the restoration of a paralyzed muscle or stimulate an optic nerve, the conducting power of which has been lost, and thus give back the eyesight that otherwise would never have returned.

This law that force results from decomposition of matter is just as absolute, so far as the nervous system of man and other animals is concerned, as it is in its relations to inorganic matter. With every thought, however trifling it may be, a certain amount of gray nerve tissue is decomposed, and the products of this destruction entering the blood are carried off by the skin, the lungs, the kidneys, and other excretory organs, and discharged from the system as effete material to enter into new combinations, and perhaps to reappear in the course of no very long period of time in the form of potatoes, or turkey, or beef, and again to be deposited as new gray nerve tissue. Thus the sequence of composition and decomposition continues while life lasts—yes, and after life has departed and the whole dead body returns to the earth from which it came.

And thus the change goes on, not only with every thought that is conceived, with every emotion that is felt, with every perception of sight, or hearing, or touch, or taste or smell that puts us in relation with the external world: with every act of the will, gray nerve substance is decomposed and new matter primarily derived from the food we take is deposited from the blood to take its place.

But this is not only true of the force-producing centers; it is equally a fact with the various organs of the body on which the force acts. Thus the liver secretes bile, and a portion of its substance is destroyed with every drop of the fluid that is produced; the heart beats to send the blood, which is to preserve life, to every part of the body, and with each throb a certain part of the cardiac substance dies: the tears flow, started by some overwhelming passion, and the glands which separate them from the blood weigh less after than before the emotion which put them in action is experienced; a finger is bent, a word is spoken, an eyelid trembles, and the muscles that acted to accomplish these results part with a portion of their fibers. These are not fanciful statements. They are based upon exact experiments and are not subjects on which physiologists differ. Thus I took the gastrocnemius muscle (the one forming the calf of the leg) of a recently killed frog, weighed it accurately on an extremely delicate balance, then hermetically inclosing it in a glass tube, also accurately weighed, and then connecting its nerves with the electrodes of a galvanic apparatus, caused it to contract rapidly until its irritability was altogether lost. Then removing it from the tube, I weighed it again and found that it had very appreciably lost weight.

The fact that physical exercise diminishes the weight of the body you can establish for yourselves by a very simple but perfectly conclusive process. Weigh yourselves on a delicate balance, then exercise strongly for an hour or so and weigh yourselves again. You will find in every case that you have lost weight. Of course there would be some loss owing to the exhalations from the lungs and skin, but the extent of this can be determined by weighing again after a like period of time has elapsed, during which the body has been kept in a state of quiescence.

Several years ago, when I was more enthusiastic in such matters than I am now, I performed upon myself a series of experiments for the purpose of ascertaining the effects upon the body of rest and mental and physical exertion, and as these have a direct bearing on the subject of my remarks, perhaps you will allow me, if I promise to describe them in non-technical language, to quote some of the results to you.

I found from these observations, continued over a period of ten days, that the average weight of the body, as determined upon a balance capable of turning with the hundredth of a pound, was 196·33. I then (the food and all other factors remaining exactly the same) endeavored to ascertain the effects of what to me was unusual physical exercise. This consisted of the lifting of a weight of one hundred pounds ten feet in a minute for three periods of fifteen minutes each at intervals of an hour. This course was continued, as in the standard series of experiments, for ten days. The body was weighed every day, and the average showed 194·13, a loss of 2·20 pounds. Thus the nerve center originates the force by which a muscle is made to contract. A nerve transmits this force to the muscle and the action ensues. In no essential respect is the process different from that in the sending of a telegraphic message. The battery supplies the electricity, a wire carries it to the recording instrument, and the act is accomplished.

All this will serve to give you an idea of the mechanism of physical exercise and of some of the consequences of muscular contraction pure and simple without the interference of any disturbing factor. But did you ever notice in your own experience what a very stupid thing physical exercise, for the mere sake of exercise, is? If you want to see the weariness, the utter despair, excited by this kind of exertion, look at a dog who is turning the wheel of a churn. Or, better still (though perhaps you would experience a difficulty in finding examples in this country), study the faces of the men who are working a treadmill. Apathy, disgust, the sluggish will barely exciting the still more sluggish muscles, the facial expression scarcely more eloquent in expressing mental exhaustion than are the bowed back and semi-flexed limbs indicative of the loss of muscular energy. And if you want a still more striking picture of the degradation of objectless physical labor, look over the earlier pages of Charles Reade's novel "Never Too Late to Mend."

I remember when in the first years of my military experience I was stationed as a medical officer at the little New Mexican village of Cebolleta. A favorite punishment of the commanding officer, when the soldier's offense was not so grave as to require a court martial, was to cause him to carry stones from one pile to another, a distance of perhaps fifty feet, and when the one was exhausted and the other piled up, to carry them back again, and thus to continue for a period, according to the nature of the breach of discipline he had committed. Nothing was so much dreaded by the men as this punishment; they would have preferred almost anything else. Bread and water for a week, deprivation of liberty, stoppage of pay, even "bucking and gagging," were less unpleasant to them. And yet it was physical exercise, not cruel, not even severe, but painful from its monotony and objectless character.

I have, as have also many of the patients who have come under my professional care, made repeated conscientious attempts to do a certain amount of systematic muscular exercise every day. We have struggled with Indian clubs, dumbbells, lifting machines, and many other contrivances warranted by their inventors to bring every muscle of the body into action; but it has been weary work, and has been rarely carried on for longer than a few weeks. In my own case I know of nothing more stupid, tiresome, tedious, fatiguing, irksome, than such exertion. It leaves the mind and the body in a state approaching collapse, and one half hour of it is more exhausting than a whole day spent in hunting, or in some such exercise affording mental stimulus. It always seems to me that it is just so much time thrown away, for we cannot even think when we are swinging an Indian club or putting up a dumbbell. So far as any influence upon mental or physical well-being is concerned, I could never see that it was of the slightest service. In fact, it has always been to me and to many others whose experience has come to my knowledge an unmitigated nuisance.

Even walking in the open air without having some definite object in view, or something entertaining in the surroundings, acting as a stimulus to the mind, is a more or less wearisome business. But a promenade down Fifth Avenue or Broadway, where the houses, the people, the equipages, the shop windows, and the varied incidents necessarily resulting from crowded streets give a constant succession of mental excitations, is quite another thing, and one returns from such a walk with the body invigorated and with the mind in a state of elasticity and contentment that nothing else in the whole course of my experience with physical exercise can surpass. If a sudden demand be made for

* An address before the Faculty and Students of Union College, at Schenectady, N. Y., on Feb. 9. From the *New York Sun*.

an undue exertion of muscular power, or if some intense mental effort be required, both body and mind are ready for their work, which is performed with a degree of readiness and thoroughness that mere physical exercise without the mental interest could never effect.

In this lie the many differences that exist between the exercise of the person who takes it solitary, perhaps in his bedroom or in a gloomy gymnasium, and one who with some other object in view than that of stretching his legs or contorting his body brings into action both his mind and his muscles in the open air while walking through the ever-changing streets of the city, with a thousand objects of interest around him, or taking a tramp through a region of country new to him, with its varying scenes of mountain and stream and forest, and inhaling such air as can only be had away from the crowded haunts of man. I am not quite sure, however, but that there is more diversion and more recreation (and I stop for the moment to call your attention to these two words, "diversion" and "recreation") in Fifth Avenue than there is in the Adirondacks or the Rocky Mountains. I have tried them both very thoroughly, and I think I have a right to speak with some degree of positiveness on this point. However, this is, after all, a matter of taste and education; but as for me, I confess to liking houses and men and women better than I do trees and chickens and cows.

But after all, nothing is more desirable in the way of muscular exertion than to engage in some athletic contest, that not only draws upon the body for all its muscular tact and vigor, but that also calls into exercise the faculties of the mind in all their categories of perception, intellect, emotion, and will.

The ancient Greeks and Romans well understood the facts upon which I have laid stress. They thoroughly knew the advantages of mental stimulation as the accompaniment of physical exercise, and hence their youths were encouraged to enter into contests with each other for supremacy in running, wrestling, throwing the discus, or boxing with the cestus. Every prize fighter knows that he is more fatigued after an hour's contest with a dummy in the shape of a hollow rubber ball or a cushion of some kind than he is after a standup fight with the gloves for the same period with an active antagonist against whom he is obliged to employ not only his muscles in all their activity and strength, but his perceptions in their utmost acuteness, his intellectual faculties in some of their most highly developed forms, his emotions to spur him on in the hope for victory, and his will to set his muscular mechanism in action and to cause it to functionate with its most intense degree of agility and power.

Exercise, for the mere sake of exercise, is to many persons the very quintessence of weariness, and it is impossible to believe that it can in such cases be productive of the maximum of benefit which muscular exertion is capable of affording. Fatigue ensues much more quickly and is more pronounced than when the mind is exercised simultaneously with the body. A young woman will go through an amount of muscular exercise in a ballroom that would be impossible for her in the performance of some laborious task in which she took no pleasure. I have no doubt that some of you have experienced like results after rowing in a sham boat in the gymnasium and a spirited contest on the Mohawk with a man rowing against you, and thus calling into exercise all the ambition, the judgment, the firmness, the will power, that the gray nerve substance of your cerebral cortex could evolve.

And then on the ball field what a splendid arena there is for the exercise, not only of all the physical strength and endurance you possess, but also of those higher mental faculties that such rivalry will always call forth in an American youth, and in the exercise of which he fits himself for the struggle that is before him! That is the kind of exercise that the professional man and the scholar require.

I am quite sure that there is a variety of physical exercise which is not practiced as much in this country as it ought to be, and which of all others stands preeminent as the kind most efficacious in developing the muscles, and at the same time calling into action those mental faculties, the degree of development of which makes the difference between the man of strong and noble mind and the one of feeble and mean mentality. I refer to fencing. It is pre-eminently an exercise of the mind and body, one that requires in the highest degree not only strength but activity and quickness of movement, while at the same time the mind, in all its faculties, is kept alert, not only so far as attack is concerned, but in studying every muscular movement and every idea of the adversary, so as to anticipate his intended onslaughts before he can make them.

It has been well said by a recent writer on fencing that "the beneficial effects of moderate fencing to persons of weak constitutions, or of studious and sedentary habits, have been attested by medical practitioners of the first eminence. To the public speaker the practice of the fencing room has been found to impart an ease and freedom of gesture attainable by no other exercise. For, while the use of the foil and the broadsword diffuses ease, elegance, and grace all over the body, and imparts to the look and gesture an appearance of intellectual vigor, it teaches invaluable lessons of patience and self-command, and contributes to discipline the temper. 'Perhaps there is no exercise whatever,' says Mr. Roland (Theory and Practice of Fencing), 'more calculated for these purposes (developing and cultivating bodily strength and activity) than fencing. Riding, walking, sparring, wrestling, running, and pitching the bar are all of them certainly highly beneficial; but beyond all question, there is no single exercise which combines so many advantages as fencing. By it the muscles of every part of the body are brought into play; it expands the chest and occasions an equal distribution of the blood and other circulating fluids through the whole system. More than one case has fallen under the author's own observation, in which affections of the lungs and a tendency to consumption have been entirely removed by occasional practice with the foil.'"

The will travels through a nerve to a muscle at the rate of about seventy feet in a second. A muscle cannot move at a rate of speed the one-tenth part of this. We conceive an idea and exert a volitional impulse upon an arm, for instance, much quicker, therefore, than we can obey the command and move the limb. In fencing, and, indeed, to a less extent, in all athletic contests, those who can form a correct idea of the purposes of their adversaries, who can send the will through their nerves with the greatest rapidity, and whose muscles obey their behests with most promptitude and power, will be the winners. Is it not, therefore, apparent that such exercises train both mind and body for the battles of life, and that it is not unreasonable to assert that, other things being equal, the best fencer or ball player will carry off the most prizes when he contends for scholarly, professional, or business success?

Mere physical exercise cannot of itself prepare a man for any higher position in the social scale than that of "a hewer of wood and a drawer of water" for him who knows how to use his brain. Those who spend their early lives in physical labor, and rise to high estate, do so in spite of their muscles. The brain asserts its superiority, and muscularity is relegated to the background. Lifting heavy weights, following a plow, or breaking stone, does not develop the brain. Such occupations enlarge the muscles and increase their strength, but the professional man or the scholar does not expect to make his mark in the world by his muscular power. It is his brain that is to be strengthened, and his muscles require no more exercise than is sufficient to keep them in a healthy state of repair, to preserve them from rusting, as it were; and this they get in the daily routine of normal life without any special means being taken to procure it.

I think that a daily walk of three or four miles in the open air at the rate of about three miles an hour, with such swinging of the arms as nature has provided for in arranging the gait of man, is sufficient. If this is taken on a gymnasium track, or in an inclosed and artifically heated piazza, it will lose some of its good effects, but will still serve the purpose of promoting that metamorphosis of muscular tissue—that removal of old substance and the deposit of new to take its place, which it, in common with all the other structures of the body, requires for its well being.

But the man who uses up his nerve force in producing muscular contractions runs the risk of not having enough for the other requirements of the system. In such circumstances a condition exists which may be well represented by the simile of the man who has steam power to let. Some of it goes to a silversmith, we will say, some to a printer, some to a miller, some to a man who has an office building with elevators in it. Now, if the silversmith uses up more steam power than his due proportion, all the others suffer. The printer cannot print his books, or the miller grind his grist, and the elevators refuse to budge. So it is with man. Excessive use of nerve force in one direction causes imperfect action in other organs; the heart beats feebly and irregularly; the gastric juice not being secreted in sufficient quantity, leads to dyspepsia; the brain, giving an undue amount of nerve force to the muscles, has not enough for its higher functions, and thus it is that those athletic men who make athletic exercises the main object of their lives are rarely, if ever, noted for great intellectual power. The ancients recognized this fact, and hence Samson, the strong man of the Bible, and Hercules, the athlete of profane history, were poor, simple-minded fellows, easily imposed upon, and, like most other amiable men (men, not women; all women should be amiable), deficient in mental vigor.

It is a matter of daily experience that when the muscles are exercised beyond the point to which they are accustomed, a sensation of fatigue is felt, which becomes more intense, and even painful, if the exertion be continued. Make the experiment of trying to hold out your arm at a right angle to the body for five minutes, and if you have not habituated yourself to this effort, you will obtain a very clear idea of muscular fatigue. In such an action the deltoid muscle, which forms the rotundity of the shoulder, is the one mainly brought into use, and it is here that the pain is chiefly felt. What is the cause of this pain? Is it the direct result of the contraction of the muscular fibers? In a word, is muscular fatigue produced solely by muscular contraction, or is there some other factor acting as a causative agent? If solely and immediately due to the action of the muscles, why do we not always feel it when we have exercised them to an extreme degree? Recent investigations go to show that there is another cause, and that is that the muscles, in contracting, suffer, as we have seen, a certain amount of destruction; lower grades of substances result, and some of these are poisonous, and acting upon the muscles before the blood has time to carry them to the excretory organs of the body, exercised a poisonous effect and give rise to that sense of painful fatigue which we all know so well.

Such poisonous substances are produced in the life course of every person through the action of the several organs of the body, and if not promptly removed from the system, lead to the development of one or more of those diseases by auto-infection which have just begun to be studied, and which are of such surpassing interest to the physician. Now, it is scarcely a matter for doubt that when muscular exercise is carried on with disgust, or at least without pleasure, these poisonous agents are formed in great abundance and removed with less celerity than when the mind co-operates with the body to give zest and interest to the work. The convict laboring at the crank, or on the treadmill, readily breaks down, and perhaps dies, poisoned by the excretions from his own muscles. Ought not such facts to have their weight with social economists in their search for the best methods not only of punishing, but of reforming criminals? And when they are sufficiently recognized by the medical profession and the public, we shall hear less of so-called neurasthenia and nervous prostration, and very much less of that terrific insomnia with which so many brain workers are afflicted; for the brain, like the muscles, has its diseases produced by overwork.

And now, my friends, I must bring these imperfect remarks to a close, though there are other important features of the subject that, were there time, might well engage our attention. But I cannot end without requesting you to bear in mind that I am no enemy of proper physical exercise. I am, however, opposed to the apotheosis of muscle at the expense of brain. A man cannot be great in two opposite directions. There is no instance on record of a great athlete being at the same time a great scholar or professional man. We do not go to the Corbetts, the Mitchells, or the Sullivans for the presidents of our colleges, for our eloquent preachers, our learned jurists, our wise physicians, our skillful and gallant generals or admirals. The mental force of man has its limit of quantity, and no one, strive as he may, can exhaust it in physical labor and yet have enough left with which to achieve mental greatness. If I have succeeded in impressing this fact upon your minds, and in pointing out to you what kind of muscular exercise is best, I shall feel that I have been of some service to you, and that my friend did not err when he asked me to participate in the course of lectures he has so worthily established.

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## EARLY ENGLISH LOCOMOTIVES.

A RECENT number of *Engineering* gives illustrations, which we copy, of two early English locomotives which were exhibited by models at Chicago. Fig. 1 shows Trevithick's tramway engine. The model was made at Crewe Works, and is an exact representation of the engine as built in 1803. In weighed in working order 5 tons, and took a gross load of 25 tons at a speed of 4 miles an hour over a bad road, with sharp curves and stiff inclines, and without a load it is reported to have run at a speed of 16 miles an hour.

Fig. 2 shows a full sized model of the "Rocket." The model was made at Crewe Works, and represents the original engine as it appeared when competing for the prize of £500 offered by the Liverpool and Manchester Railway Company, at Rainhill, in 1829. The engine weighed in working order 4 tons 3 cwt. ; it ran at the rate of 12½ miles per hour with a load equivalent to three times its own weight, and when taking a carriage and passengers it traveled 24 miles an hour.

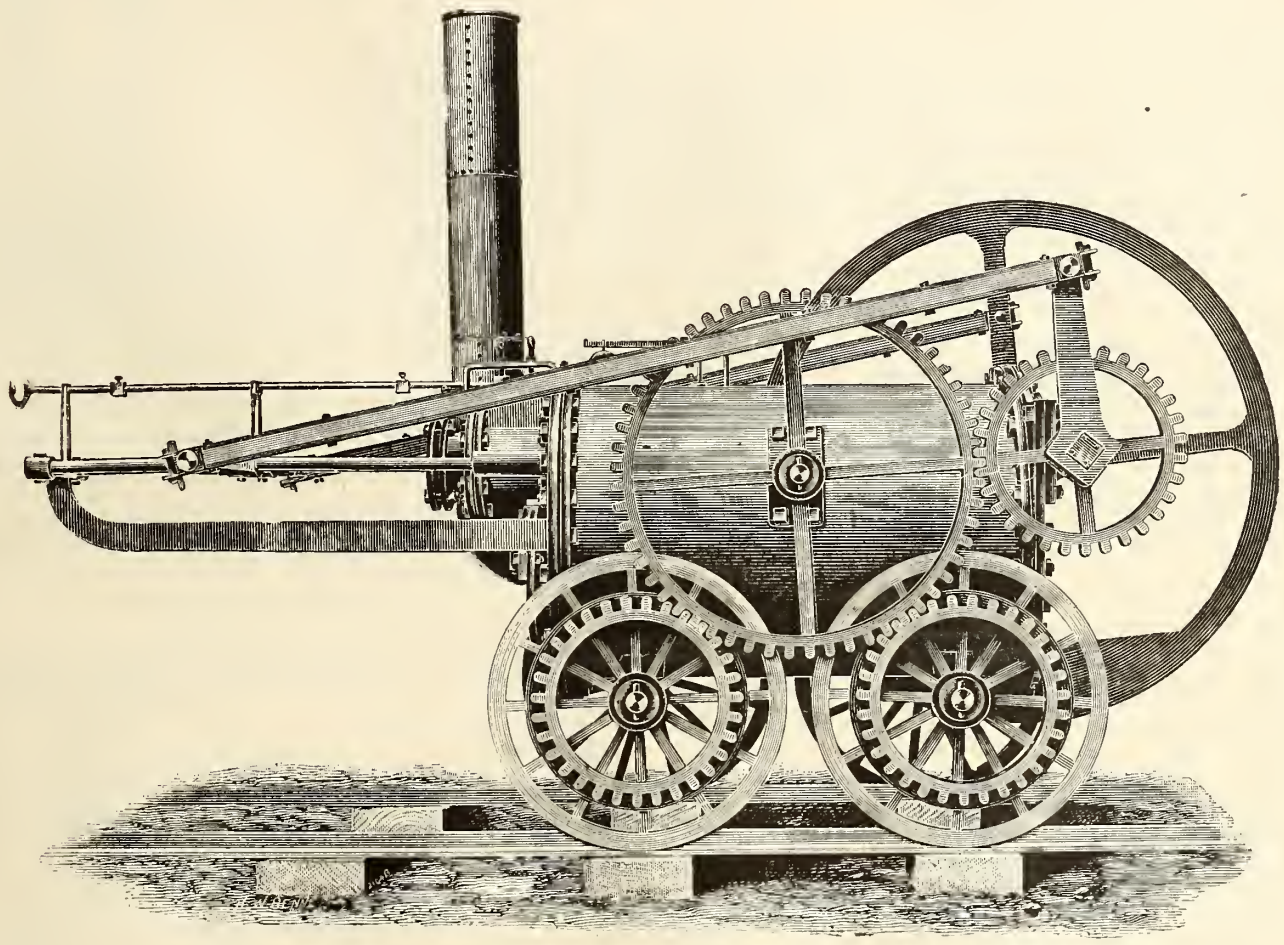


FIG. 1.—MODEL OF TREVITHICK'S TRAMWAY LOCOMOTIVE, 1803.

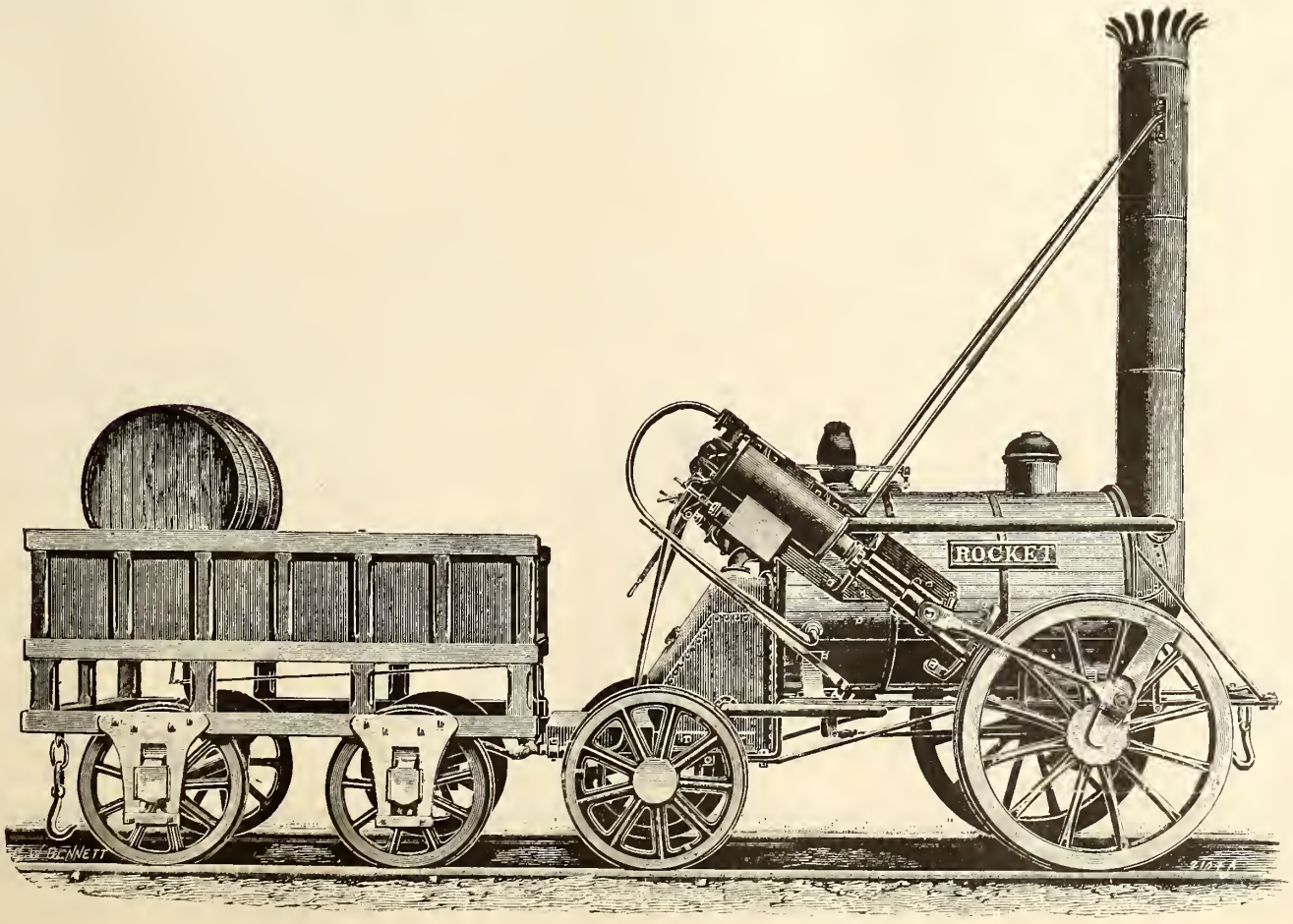



FIG 2.—MODEL OF STEPHENSON'S "ROCKET," 1829.

## WATER TUBE BOILERS.*

We propose in a short series of articles to explain the principles involved in the design and working of water tube boilers; the conditions which, for various purposes, they ought to fulfill; and the constructive arrangements most likely to satisfy these conditions. We do not intend to supply historical information. It is not our purpose to describe in detail any boiler or method of construction. Our criticisms must not be taken as directed against any particular make of boiler. What we shall have to say in favor of a system or systems must be regarded as wholly impersonal. In other words, having laid down certain principles to be observed in designing water tube boilers, our standard of merit will be based on the extent to which these principles are observed.

In the present day steam is always generated either in cylindrical vessels or in flat-sided chambers the plates of which are stayed together. The locomotive boiler supplies an example of both methods of construction. The fire box and its casing are flat-sided stayed structures. The barrels of the boilers are cylindrical vessels. The water tube or tubulous boiler differs from others principally in the size of the tubes. But it must not be forgotten that many types of water tube boiler have cylindrical vessels of very considerable dimensions as component portions of their structure, while in others flat-sided stayed chambers are used.

Seeing that boilers of the Lancashire, Scotch, and locomotive types give excellent results, it may legitimately be asked why the water tube boiler should supersede them. The question admits of several answers. The principal are: (1) That the water tube boiler is safer at heavy pressures than any other. (2) That it is much lighter. (3) That steam can be got up more quickly in it; and lastly, that it is more portable, in that it can be conveyed from place to place in portions or sections, easily handled, and of very moderate weight. It may be taken as certain that the water tube boiler is not more economical than other forms of steam generators, assuming of course that we select favorable examples of each type.

Almost all inventors of water tube boilers have started with the fundamental proposition that good water circulation is to be obtained at any cost. It is, however, a remarkable fact that most erroneous opinions are held concerniug circulation and its cause, even by those who ought to be very well informed on the subject. As a matter of fact, however, it can be shown that circulation is not necessary; that it cannot be avoided, and that it is always to be considered simply in the light of an evil. Circulation is due to two causes. The first of these is difference of density in two portions of a body of water, the difference being due to diversity of temperature. If the water throughout a boiler is all of the same temperature, there will no longer be circulation from this cause. In Fig. 1 circu-

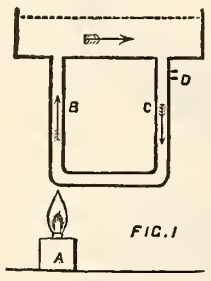


FIG. 1

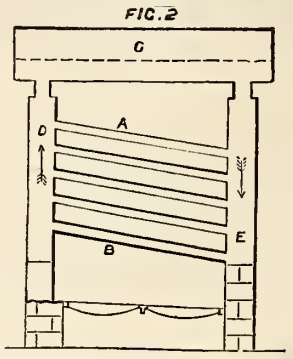
lation will take place in the direction of the arrows when the lamp, A, is placed as shown, but only so long as the water is becoming hotter. As it gets nearer and nearer to 212°, the circulation will become slower and slower. It is no longer possible to make the water in B any hotter; but C may be kept colder, as by a current of cold air, and circulation will then go on—but only because a portion of the water is kept below the temperature proper to the pressure at which the rest of the boiler is generating steam. The principle has been extensively employed by many inventors, and in some cases the cold feed has been delivered somewhere about the point, D, in order to keep down the temperature still further. A little reflection will show that so long as water is kept in contact with a heated plate or tube, it matters nothing whether that water is circulating or not, it will absorb heat and give off steam; but care must be taken that the steam does not drive away the water. It is because it has driven away the water that so many water tube boilers have turned out more or less disastrous failures. It is before all things necessary for those designing water tube boilers to have perfectly pellucid views on the subject of circulation. Lacking this, it is quite impossible for them to attain success. Now, the simple rule to be observed is this: "Take care of the steam, and the water will take care of itself." That is to say, the boiler must be so constructed that accumulations of steam in one portion may not force the water out of that into another portion. That is what took place in the historical boilers of the s.s. Montana. The tubes out of which the water was driven became red hot and burst. Furthermore, it must be remembered that different portions of the boiler are exposed to different intensities of heat, and the steamway which may be large enough to clear the tubes in the cooler portions may be altogether inadequate to clear those in the lower portions. Thus, for example, the steamway which may suffice for A, Fig. 2, may not be great enough for B, the ultimate delivery from which into C is hampered by the discharge from all the pipes above it into D. If a boiler of this kind, wrongly proportioned, is worked quietly it may do very well. If it is forced, B will be emptied, the water being driven back into E. If the fire is very fierce, the lower tubes may be ruined in this way; if not, then water will be taken by gulps into B, and the result will be unsteady working, and priming more or less severe. This is a principal reason why the numerous class of boilers with long pipes and deep "headers" have proved themselves unfit for forcing. They answer very well with moderate draught and an evaporation at the rate of about 2½ lb. to 3 lb. of water per square foot of heating surface per hour. For higher

* From the *Engineer*, London.

rates they have to be specially proportioned; but under no circumstances are they suitable for the very highest rates, such as those obtaining in torpedo boats.

It is erroneously held by many persons that circulation takes place after ebullition has commenced, under such conditions as those indicated in Fig. 1, because the leg, B, contains steam and water, while the leg, C, contains water only; and even so eminent an authority as the late Mr. Babcock maintained that the maximum useful circulation was obtained when the contents of the ascending leg weighed just one half as much as the contents of the descending leg. This implied, of course, that the bubbles of steam in the former must be equal

FIG. 2




in volume to the volume of water in the leg. There is no foundation in fact for this theory. If it were true, it would suffice to displace half the water in the ascending leg with corks to get circulation with cold water. Those who hold the same view as did Mr. Babcock forget that the pressure of water is a function of the head and not of the mass; and so long as the head of water is the same in B as it is in C, it matters nothing what may be suspended in B, there will be no circulation. This is very clearly proved by the aid of bent glass tubes, provided they are not too small in diameter, when an action takes place to which we shall refer by and by. If the experiment is properly carried out, a continuous upward rush of steam bubbles may be maintained in one, while there is practically no movement of the water. We have no doubt that in some forms of water tube boiler there is no circulation of the water worth mentioning. Indeed, the only arrangement maintaining circulation, consisting of an external down pipe, has been removed, and the boiler has in no way suffered. As a rule, however, in all water tube boilers there is circulation of water, and in some it is exceedingly violent and rapid. We have yet to consider to what this circulation is due. This we shall endeavor to explain hereafter. Before doing this, however, it is well that our readers should be in no doubt concerning the unequal density argument. It will be made clearer by Fig. 3. Here, in the

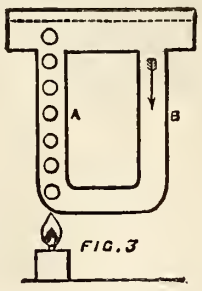


FIG. 3

ascending leg, are seen a number of steam bubbles, which, of course, displace a certain volume of water. If now it were possible to weigh the contents of A and B, it would be found that the former was much the lighter. This being so, it is held that water flows from B to A. It seems sufficient to state the case to show its absurdity. We have already pointed out that corks might take the place of the bubbles in cold water, but no one dreams of saying that circulation would take place in very many if not in most water tube boilers then. The case stands thus: The temperature of the water is very nearly the same in both A and B. Not infrequently the difference is not one degree. No circulation worth the name can then be produced by difference of water temperature. Again, the head is the same in A and B, or, rather, it is higher in A than B, so that circulation cannot be due to the difference in height of the contents of the two legs. In connection with this point, we reproduce an account of an experiment carried out in the United States, by Mr. Hogan, the patentee of a water tube boiler. Fig. 4 shows the experimental boiler. The

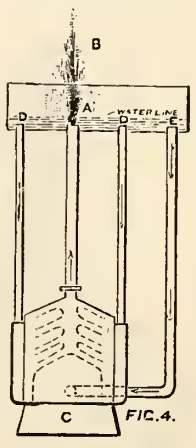


FIG. 4.

pipes and boiler were filled with water to the water line, and the water was gradually heated until the fire was in good condition. The fire was then forced, and in a few minutes water and steam were thrown upward from A to B some 20 feet. The distance from C to A was 18 feet.

It will, we think, scarcely be maintained that this action was due to the difference in weight of the columns of water, C A and E F. So long as the theory is maintained and acted upon, that a difference in the weight of the contents of the rising and falling columns is the cause of circulation, so long will faulty methods of construction be adopted. It is because that by either accident or as a result of sound knowledge the theory has been ignored, that important advances have been made in the construction of tubulous steam generators.

Before proceeding further, it may be worth while to explain the reasons why the erroneous theory of circulation which we set forth formerly has been accepted. It appears to be based on the results of experiments made with small glass tubes. We have already called attention to the misleading nature of such experiments. If, instead of a tube one inch or a little more in diameter, we use a tube with a bore of a quarter of an inch or thereabout, it is very easy to carry out an experiment in such a way that there will be no true hydrostatic head in the rising pipe. What takes place is shown by Fig. 5. Here we see bubbles

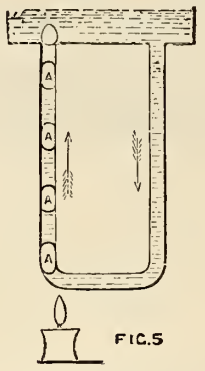


FIG. 5

of steam, A A, etc., following each other up the rising leg. Each bubble quite fills the bore of the tube, and circulation will in that case be due mainly to the difference in weight of the contents of the two legs. In practice, however, the steam bubbles hardly, if ever, fill the diameter of the tube, and all that we have said in our last impression holds good.

We have said that circulation, sometimes very violent in character, takes place in water tube boilers. We have now to explain to what that circulation is due. The cause of circulation, that is to say, of the movement of the water in the boiler, can be very briefly stated. The explanation of the working of the cause in detail will occupy a little space, which may very advantageously be devoted to it. The water is made to move by the movement of the steam. A very simple and satisfactory way of demonstrating this is to substitute air for steam.

There can be no question then of heat having anything to do with the matter. Fig. 6 will serve to illus-

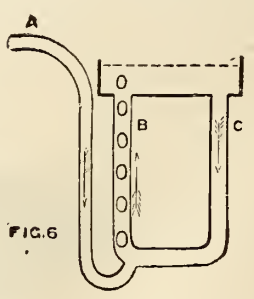


FIG. 6

trate our meaning. The apparatus being filled with cold water in which a little sawdust is suspended, it is only necessary to blow into the tube, A; a constant stream of bubbles will ascend through B, and these will set up a rising current, while the water will descend in C.

The velocity with which a steam bubble would ascend would be enormous but for the resistance of the liquid through which it moves. The weight of a cubic foot of steam at atmospheric pressure may be regarded as next to nothing, but inasmuch as it displaces, when in water, a volume weighing 62½ lb., it follows that the force urging it to rise is 62½ lb. Now, the acceleration due to the action of gravity is equal to 32 ft. per second. That would be the velocity acquired by a "mass" weighing 62½ lb. on which was impressed a force of 62½ lb. But in the case of our cubic foot bubble of steam, there is practically no mass, while there is still a force of 62½ lb. acting. Let us, for the sake of argument, assume that the bubble of steam weighed one pound; then the buoyant force being sixty-two and a half times that of gravity, the bubble would acquire in a second a velocity $=32\times62\frac{1}{2}=2{,}000$ ft. per second, and would traverse in that time a space of 1,000 ft. Of course, no such velocity as this is ever attained, because we have the very great resistance of the water retarding the bubble.

There is, besides, another and important action to be considered, which modifies the velocity of the ascending bubble. Let A—Fig. 7—be a tall vessel containing

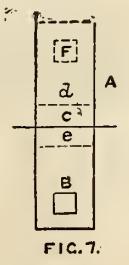


FIG. 7.

water. At the bottom is a hollow empty box, of one cubic foot capacity. Let this box be retained at the bottom by a cord or other expedient. The center of gravity of the body of water in A will then lie somewhere above the middle line C, let us suppose at *d*. If now the cord is cut, B will rise to the top and take the position shown by the dotted lines, F. But B can

rise only by virtue of the center of gravity of the whole mass of water in A falling, say, to *e*, and the velocity with which A rises is ultimately limited by the rate at which the center of gravity can fall. But a little reflection will show that the cross section of the mass of the water, or, rather, the relation of the mass of the water to that of the space represented by the box, B, has an important influence. Thus it will be seen that while B has to rise to F, the center of gravity of the contents of A has only to fall from *d* to *e*. The only importance which this fact has in connection with water tube boilers is that the larger the descending waterway the greater, other things being equal, will be the velocity at which a bubble will ascend.

Popularly speaking, bubbles of steam "float" to the top; but they acquire almost at their first formation a high ascensional velocity. We have for the sake of simplicity spoken of the bubbles as nearly without weight, but especially when we have high pressures, the steam bubbles really have an appreciable weight. Thus steam with a total pressure of 175 lb. weighs 0·39 lb. per cubic foot. Thus each bubble has momentum. It may be said to start, to begin with, at a high velocity, and from first to last it is kept back by the water through which it is moving. It pushes this water before it, and the result is an upward current, which, as far as the water is concerned, is not opposed by any resistance save that of the friction of the tubes and passages. If, then, as we have said, we take care to give the steam sufficiently good means of escape from the place where it was made, no evil consequences can ensue, no matter how much the boiler is forced; there will always be water ready to take the place of the steam.

It is by no means easy to make the action of steam and water under the conditions present in a water tube boiler intelligible to those who are unable to distinguish mentally between "mass" and weight. We believe, however, that we have said enough to make it clear that the velocity with which a bubble of air or steam will rise in water would be enormously greater than the rate at which an equal mass of matter would fall in air, were it not for the resistance of the water. On this point it is worth while to quote Mr. Krauss, of Vienna, who, writing on circulation in water tube boilers in an American contemporary, *Power*, says: "If the surface of the water is 4½ ft. above the steam bubble, the velocity of the bubble at the moment of striking the surface of the water will be 246 ft. per second, friction and other resistances in pushing aside the surrounding body of water being neglected." In this calculation the weight of the steam bubble and of a body of water the same size as the steam bubble are taken into consideration.

Mr. Krauss continues: "But it is a condition that the surrounding body of water may be pushed aside. If this is not the case, and a vertical tube be put over the steam bubble, it is seen that the bubble when rising must raise the column of water above it as well as that beneath it. The potential energy necessary may be supposed to be furnished by another and neighboring column of water. If the tube with the bubble is closed at the lower end, no movement can take place, the potential energy having no opportunity to change into kinetic energy. If the bottom of the tube is only partly closed, the movement of the column will be much slower than when the whole area is open."

In practice the velocity with which the steam bubbles ascend is, as we have explained, controlled and limited by the friction and resistance of the water. Unless the steam can get away as quickly as it is formed, it must accumulate; but steam and water cannot be in the same place at the same time, and if steam takes the place of water in a generating tube, then that tube will be overheated. The deduction to be drawn from all that we have said is that, to all intents and purposes, steam will invariably get away in any vertical tube so fast that overheating is impossible if only the steam is given fair play. Thus, for example, if we take such a model as that shown in Fig. 1, making the whole affair of tin plate put together with soft solder, the lamp may be replaced by the fierce heat of a smith's fire, without melting the solder, provided care is taken to prevent the emptying of the whole apparatus by the water being thrown out. In one word, *the* essential point in a water tube boiler is to facilitate the escape of the steam from the generating or heating surfaces.

So far it will be seen that we have dealt only with the motion of steam and water in vertical tubes or pipes. But a very large number of water tube boilers generate steam in inclined tubes. The inclination is given because a bubble of steam will run to the higher end in precisely the same way that a bubble of steam runs to the higher end of a spirit level. Those who have followed what we have said so far will now see without further explanation that the velocity with which a bubble traverses an inclined tube must be less than that with which it traverses a vertical tube, unless some other agency than the slope of the tube is brought to bear.

What these agencies may be we shall consider later on. Our readers will not, however, be slow to perceive how important it is that "headers" or "risers" in boilers of this type, through which the steam ascends to the receiver or drum above, should

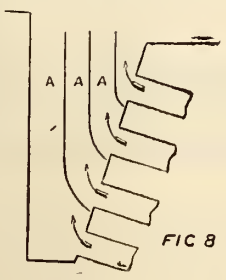


FIG 8

be of ample dimensions. One reason why boilers of this type will not stand forcing is simply that these headers are too contracted in dimensions, while the bubbles are allowed to interfere with one another.

When boilers of this type are intended for driving or forcing, the header, or "heart," as Dr. Alban called it, should be made as in Fig. 8. Constructive difficulties interfere, however. The tube ends become more or less inaccessible, because of the guide plates, A A, and certain other disadvantages are incurred. But nevertheless it is certain that we have here the elements of construction for a boiler that will bear forcing without priming.

If our readers will turn to Fig. 5 they will see that so long as the current is constant, or nearly so, in the rising limb, it must be constant throughout the whole length of the pipe; and it matters nothing what the length of the horizontal portion of the pipe is, water will flow through it for the sufficiently obvious reason that if it rises in one leg it will descend in the other, and consequently must move along the horizontal portion. That is to say, if we get the water to move in any part of a tube, it must move in the whole. The only agency which could prevent this would be the formation of steam somewhere in the length of the tube, which could not get away, and would prevent the further advance of water from the rear or lower end.

Now, if we take any boiler of say the Root type, we find that each inclined tube is virtually provided with a rising and a falling leg in the shape of the "headers," one at each end, and those tubes which are lowest and nearest the fire have longer legs than those which are higher and further removed from it. In one sense this is right, for it might be reasonably expected that a better supply of water will be secured to the lower tubes, which most need it, because the upward and downward forces impelling the water along the tubes are, in some ill-defined ratio, the greater the longer the rising and falling tubes are. But in other respects the arrangement is defective, because, as we have already pointed out, numbers of tubes arranged above each other debouch into the header; and the rush of steam and water from the lower tubes is hampered by the rush from those above. But this is not all. When boilers of this kind were first made, it was assumed that they would give beautifully dry steam; and no steam receiver or separator, save a tube which was little more than an enlargement of the steam pipe, was provided.

But as experience was gained, it was found that very large steam drums must be added, and we find such boilers fitted now with one or even two drums, 3 ft. or even 4 ft. in diameter, and 10 ft. or 15 ft. long. These are about half full of water. It was a favorite argument for tubulous boilers, that inasmuch as there was no vessel of large diameter holding a great deal of steam and water, they were safety boilers in the full sense of the term. Obviously, the use of this argument is incompatible with the presence of one or two great receivers, and consequently we seldom or never hear anything about "safety boilers" now. Early in this article we stated that circulation in a water tube boiler was a necessary evil. It is necessary in the sense that it cannot be avoided; it is an evil in the sense that it is the cause of priming. No doubt it may be said that if the boilers were properly constructed the priming would not take place, but then certain structural difficulties would be incurred. It is now time to discuss this branch of the subject more fully than we have yet done.

If we examine most of the inclined tube boilers, we shall find that the "header" or "riser" communicates with the receiver above through a comparatively contracted passage or neck. For obvious reasons none of our sketches are intended to refer to any particular boiler. But Fig. 9 will explain what we mean by a

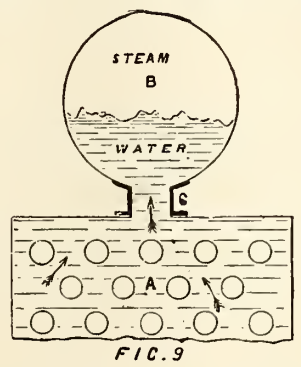


FIG. 9

contracted passage. A is the riser or header into which open the ends of the generating tubes. It is not remarkable that as the whole of the steam generated has to pass up through the neck, C, there is a violent uprush of steam and water quite thoroughly mixed, and a very considerable cubical space is required to give time for the water to fall away from the steam. The sketch in no way exaggerates the conditions in many boilers which we have seen. The result of the pretty free adoption of this method of construction has been the invention of a host of devices for getting dry steam. Of course prevention is better than cure, and if due care is taken to provide for the free delivery of the steam, there will be very little trouble from priming, which there must be so long as the steam has to rise through a great depth of water and escape through a small surface. To provide a free delivery for the steam, the neck should be entirely dispensed with and the risers worked into the steam drum in a way that will be very easily understood from the sketch, Fig. 10.

We are not aware of the existence of any boiler made in precisely this way, but we do not pretend to say they do not exist. But it is easy to see that the method of construction entails difficulties and is open to objection. Thus a boiler so made would not be eminently portable, because it could not be in the proper sense of the word sectional. As to first cost, it is possible that the reduction which might be effected in the size of the steam receiver would compensate in part, at least, for the extra outlay on construction; but on this point we are doubtful, because the plain cylinders with dished ends, which are used as separators, are, after all, about the cheapest possible expedients that can be made. But, furthermore, it will be seen that such a design entails a radical change in the whole method of construction. It would, in effect, mean a return to Dr. Alban's "heart," the tubes opening into a flat-sided stayed chamber, instead of into sectional jointed "headers," often made of malleable cast iron, cheap and easily renewed. As it is absolutely essential that the tube ends should be accessible, doors or their equivalents must be provided; and these will be under pressure and must be jointed steam and water tight. In this circumstance lies one of the great differences between boilers with water inside the tubes and those with water outside them. In the latter we have only to make one set of joints—those between the tubes and the tube plates—tight. In the former we must make not only the tube ends tight, but the access doors as well, and the latter is the more difficult of the two. If now the design we have sketched in Fig. 10 were carried into practice, the front plate of the heart must either be fitted like the lid of a valve chest with studs and nuts, so that it could be taken off, or else it

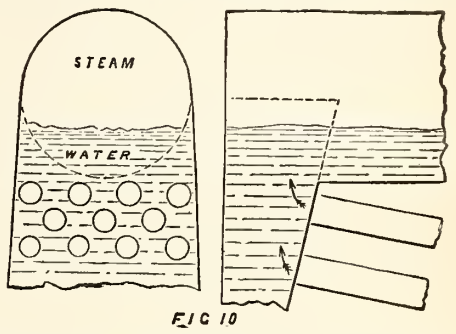


FIG 10

must have as many, or nearly as many, holes as there are water tubes, fitted with doors, one opposite each tube, and, in addition, the flat sides would have to be stayed. The result would be, of course, that in a large boiler it would be nearly a day's work to get a front plate off to clean or replace perhaps only a single tube. However, boilers with removable plates were made by Dr. Alban with success, and they have also been tried in the United States, not, however, so far as we can learn, with much satisfaction. That is to say, such boilers have not become popular; they have not been a commercial success. We find that most makers build up the headers and deliver all the steam made through comparatively contracted necks and rely on the action of the receivers for getting the steam dried. That the result is, on the whole, satisfactory seems to be demonstrated by the popularity enjoyed by water tube boilers for electric lighting and other purposes on land.

But it must never be forgotten that such a method of construction is quite unsuitable to forcing. The effect of that is to drive such a torrent of water, mixed with steam, into the receiver that no subsequent manipulation will prevent priming.

We do not hold, however, that this is any disparagement of a very useful class of steam generator. On the Continent it has long held a high place place in popular esteem. It permits the adoption of grates so large that any kind of fuel may be burned, even town refuse; and, provided the boilers are not hurried, they will give steam about equal in quality to that obtained from a Lancashire boiler. In this country we have not been content with this. We have tried to get more out of the boiler than it was ever capable of doing. We have attempted to win the Derby, so to speak, with a cart horse, and then we have fallen foul of the cart horse as though it were his fault. The result of pristine failures was that for many years the water tube boiler met with small favor in this country. We may digress here for a moment to say that we believe that it will be found advantageous to adopt a special name for water tube boilers which will stand forcing, and we do not think that a better word than "express" is available. Now, experience extending over many years has shown that no water tube boiler with long inclined tubes of large diameter can do "express" work; and to avoid all chance of being misunderstood on this point, we shall summarize the reasons why they cannot.

But in doing this we shall leave out of consideration all objections which might be urged against them, on the ground of their external characteristics; such, for example, as the necessity for placing them in brick ovens, their great length, etc., and confine ourselves to what goes on within them. The first objection is that the tubes being of considerable dimensions, say 4 in. diameter and 12 ft. to 15 ft. long, the qualities available in the market, although very good, are not good enough to stand for any lengthened period the tremendous heat due to forcing the fires. The second objection is that the tubes immediately over the furnaces are exposed to so high a temperature that they are bound to make an enormous volume of steam, and the length of the tube is so considerable, and the delivery of steam from it so hampered, that it never can contain much but froth when the fire is driven, and very great risk of burning and splitting the tube is entailed. In the third place, the delivery of steam from the tubes takes place through an area so contracted that priming can scarcely be avoided. Other arguments might be adduced, but after all they do not seem to us to be needed, for no one in the present day dreams of forcing boilers of this type. We have only referred to their unfitness for the purpose, because they have been tried for marine purposes and failed, and because even now patents are constantly being taken out for boilers which are but modifications in detail of the Root or De Naeyer type, intended to adapt them for use at sea. The express boiler is radically different from the normal tubulous boiler. It is almost a new departure in boiler engineering, and we have now to consider why it does work that its predecessors cannot.

*(To be continued.)*

CYCLING IN RUSSIA.—The bicycle is but little encouraged in St. Petersburg. Wheelmen there are restricted to the use of certain streets, which are for the most part so wretchedly paved as to make riding through them almost impossible. No person under the age of eighteen may enjoy the privilege of cycling, and no very high machines are allowed in the streets. Another order provides that after dark no cycles of any sort shall be permitted.

# THE AUTOMATIC BALANCE OF RECIPROCATING MACHINERY AND THE PREVENTION OF VIBRATION.*

By W. Worby Beaumont, M. Inst. C.E.

Vibration, set up by machinery of various kinds, has often given rise to problems of great difficulty, and the cause of the vibration has sometimes been as obscure as the phases of variation in its transmission have been mysterious. The character of the vibration differs with different classes of machinery and with the same machinery working at different speeds. It is intended in this paper to deal with a limited class of machines and to refer more particularly to those in which the essential parts reciprocate or gyrate at a high speed or not at a low speed. It is, moreover, intended to deal chiefly with machines in which the reciprocating or gyrating part receives motion from a source, and is not the source of rotation, as in steam engines, although brief reference will be made to vibration set up by the latter, and to its possible prevention. The tendency of any unsymmetric mass to rotate about its center of gravity, and to rotate the axle or shaft upon which it is running round that center, when it is not coincident with it, may be prevented, by additions to the mass which move the center of gravity of the whole to the center of rotation. This simplest case, however, is frequently complicated in practice by the impossibility of placing the rotating parts in the same plane. Generally, the difficulties in connection with these cases are much less than those in which a motion of reciprocation or of gyration is imparted by means of a rotating part.

In almost all cases, motion of one or other of these kinds in the machinery now to be considered is effected by a crank shaft and connecting rod, or an equivalent of these; and, except where the crank has three or more dips connected by rods, which move reciprocating parts simultaneously in opposite directions, the perfect balance of such a crank and connected mechanism is very difficult and almost impossible.

In some cases, the use of a heavy fly wheel, with only as much unsymmetric weight as will balance the

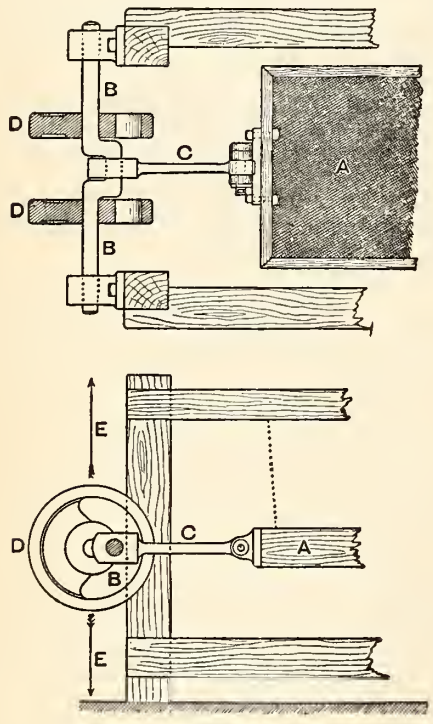



Fig. 1.

crank and the connected reciprocating parts, will approximate to this result; but the weight of wheel necessary to secure the smooth running of machines in which the main parts are reciprocated at high speed has numerous practical disadvantages, which generally precludes its use. It is common to balance, as it is called, the crank and connecting rod by eccentric weights, which frequently are very much heavier and at the speed of their rotation have momentum much greater than the parts supposed to be balanced. This is in consequence of the necessity for opposing the inertia of motion, not only of the crank and connecting rod, but of the heavy reciprocating part operated by the crank, and alternately its inertia of rest. This necessarily throws large stresses upon the crank shaft and its bearings, which form the abutment against which the pull and push of the crank acts and reacts. These bearings have to be—in all cases—fixed to the framing of the machine, part of which is to be reciprocated or gyrated, or to something which relatively to that part is at rest. The action and reaction resulting from the working of the machine is therefore, except in so far as it is balanced in one direction, transmitted to the framing of the machine, or the building foundation, or floor to which the bearings are attached. By the use of heavy eccentric weights on the crank shaft in the way mentioned, the effect of the push and pull on the connecting rod may, in the direction of motion of the thing reciprocated, be eliminated, but in the direction normal to this, a nearly equal action and reaction is experienced by the bearings in consequence of the influence of the rotating eccentric weight. This may be shown by reference to the diagram, Fig. 1, in which A represents the part to be reciprocated; B, the crank shaft; C, the connecting rod; and D D, eccentric weights, in the form of disks, heavy on one side. In the direction of the length of the part A, which may be a sieve of the several kinds used in flour mills, or a screen for crushed minerals, the inertia and momentum are equal, and are approximately balanced by those of the eccentric rotating weight, D, but in the vertical direction, as indicated by the arrows, E E; the work done by the weights, D, in balancing forces in a horizontal direction is also done in the vertical directions, E E, by these weights, or, more correctly speaking, the vertical upward and downward force exercised by these weights is nearly as great as the horizontal backward and forward force exercised by them in balancing the movement of the reciprocating part. This force, the vertical action of the rotating eccentric weights, sets up vibration in the floor or foundation on which the machinery stands, and, generally speaking, the action of the weights is not confined to a vertical direction, but departs therefrom sufficiently to set up racking stresses in the frame of the machine.

* A lecture before the Society of Arts, London, Feb. 7, 1894. From the Journal of the Society.

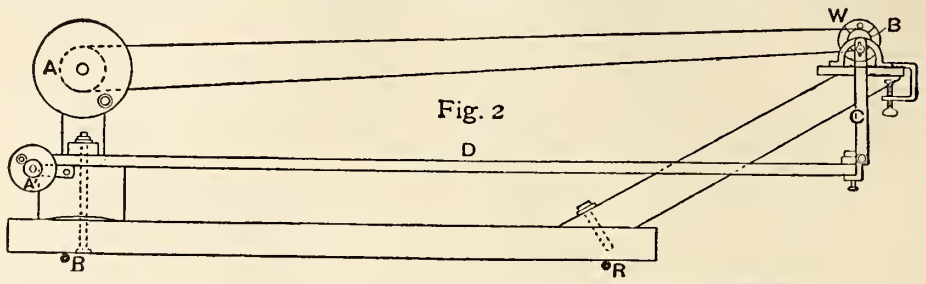



Fig. 2

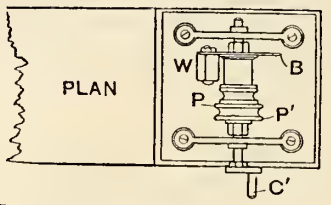



Fig. 4.

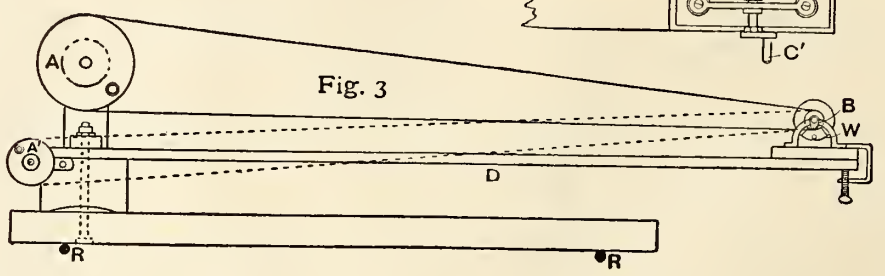



Fig. 3

The whole of the work done in this way is lost work, and some idea of how much that loss may be can be shown by the working of the model marked A, Fig. 2. In this model, vertical motion of small range is imparted by a crank and connecting rod, C; the weight of the crank and connecting rod being balanced by an eccentric weight, W, on a disk, B, on the crank shaft. So long as the piece, D, to which motion is communicated is thus operated, the eccentric weight acts as a balance weight; but it will be seen from the indicators on the model, which, for the purposes of explanation, magnify the range of vibration set up, that the effect of the push and pull on the arm, D, of the machine represented by the model is very considerable. In this respect it represents the condition of working of a good many machines—vibration—which is only prevented by excessive strength and excessive weight. Some idea of the effect in the vertical direction of the balance weights, D, used in the machine represented by Fig. 1, may now be conveyed by allowing the corresponding balance weight, W, in the model, Fig. 2, free scope, by placing the crank shaft and its bearings on the part, D, of the machine represented by the model to which reciprocating movement has to be communicated as shown also in Fig. 3. The connecting rod is dispensed with, and the framing of the machine is relieved of the bearings, so that any work in the vertical direction, or force exerted by the balance weight, will now be expended on the part to be moved, and only on that. The balance weight is now unbalanced by that of the connecting rod and its connections, and by rotating the crank shaft it will be seen that the essential part of the machine now receives vertical movement, just as it did before the connecting rod was removed. This is the effect when the speed of rotation is greater than the elastic period of the part D of the machine moved. If, now, the speed of rotation be altered, so that it may coincide with the elastic period of the part, D, to which the shaft is attached, it will be seen that this same little, out-of-balance weight will set up motion of a very large range. Thus may be afforded some idea of the harmful vibrations which may be set up in the floors and walls of buildings containing machinery, in which forces, otherwise unbalanced, are originated. It must be noted that the force which gives rise to the vertical movement in the machine shown by the model is equally active in tending to produce motion in the direction of the length of the reciprocated part, and it is only opposed by the weight and fixity of the frame of the machine. The force is, however, available for setting up motion or vibration in the horizontal direction of that to which the machine is attached.

Very many machines, such as that represented in diagram, Fig. 1, may be made to perform their work by a gyratory instead of a reciprocating motion, and such machines in considerable numbers and of several kinds are used for the sorting and sizing of grain, crushed ores, and in flour mills. A simple form of such a machine was represented by a diagram on the blackboard, in which, as before, A represents a sieve; B, a crank shaft; C, a crank disk carrying a crank pin, by which motion is given to the sieve. The disk, C, is heavily weighted on the side opposite the crank pin, so that the disturbing forces, set up by the gyrating sieve, may be, to some extent, balanced and thereby eliminated. The reaction, however, of the force exerted by the crank pin is equally and oppositely experienced by the bearing, B, with the result that the framing of the machine within which the sieve, A, is suspended must be made of great strength, and it is commonly necessary, even with this strength, to prevent the rocking of the frame by connecting it by struts or ties to the building in which it is fixed. Now the whole of the work expended in setting up vibration of the frame of the machine or the building containing it, is not only waste work, but it is a very harmful waste.

It is one of the chief objects of this paper to show that by far the larger proportion of all the machines in which vibration is set up by reciprocating parts may be so constructed that the waste referred to may not only be prevented, but may be converted into useful work, employed in the operation of the essential parts of the machine. It will be shown that this may be done in such a way that the parts operated shall experience much less severe stresses than in any of the arrangements commonly used.

The method of working now to be shown includes a new mechanical motion, involving something of the nature of a mechanical paradox; but it secures a perfectly automatic balance in itself and in the thing it operates. Instead of attempting to make an accurate balance, according to methods hitherto adopted, the author proceeds in an exactly contrary direction, and purposely puts that which gives rise to the motion out of balance.

The cause of vibration, which has hitherto been a source of the greatest trouble to mechanical engineers, is thus converted into a useful servant, and in many cases that which has been a harmful mechanical by-product is utilized and made to do the whole of the

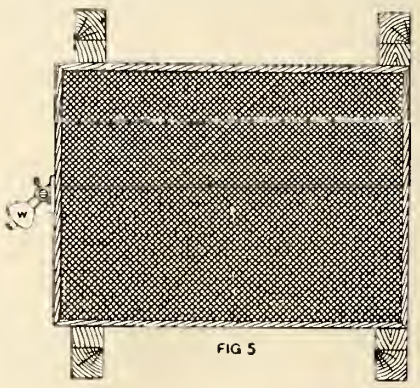



FIG 5

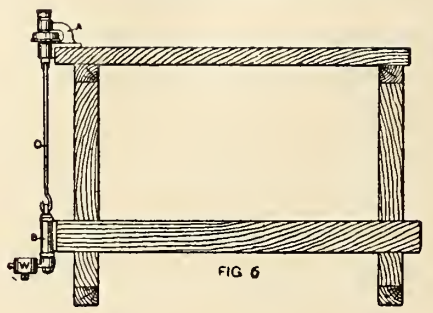



FIG 6

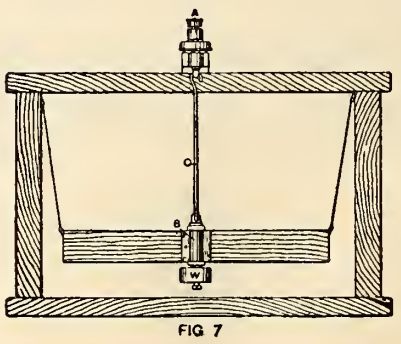



FIG 7

work of which it is an offshoot. In brief, the cause of vibration is converted into a vibromotor.

In the model marked B is a part corresponding to that marked A in the diagram, Fig. 1, operated by means of a crank shaft and weighted disk. To the frame is attached an indicator, which makes visible the vibration set up in it by the wasted reactions. By removing the crank shaft from the framing, and leaving the latter only the work of supporting the sieve, and then operating the sieve by the means which now have to be described, it will be seen that the frame is relieved of those stresses, and, therefore, of the vibra-

tory effects, while the work of operating the sieve is materially lessened. To the sieve is attached the bearing for a small spindle which carries an eccentric weight, W, Figs. 5, 6, 8, 9, equivalent to that of the weighted part, C, of the crank disk, in other words to carry an unbalanced eccentric weight. This small spindle is rotated by a flexible or jointed connection, C, which is free to move with the movements of the sieve. Now, as will be seen from the working of the model, B, the rotation of this eccentric unbalanced weight sets up movement by its reaction at every part of its rotary path, but it is now running in a bearing, which is attached not to the framing of the machine or any fixed part, but only to that which has to be moved, namely, the sieve, A; hence every action and reaction now set up respectively by the rotating eccentric weight and the sieve is expended entirely in the operation of the latter. This being the case, there is now no vibration set up in the framing of the machine, as is shown by the quietude of the indicator, which before was violently agitated. Other models, C, D, are shown, which further illustrate this, motion being conveyed, in one case, to a reciprocating part by a driving spindle which runs in a bearing attached to a freely suspended frame. Another model, similar to that shown in Figs. 5, 6, 7, 8, 9, is also exhibited in order to show how a gyrating screen may be operated by means which automatically balance all the disturbing forces.

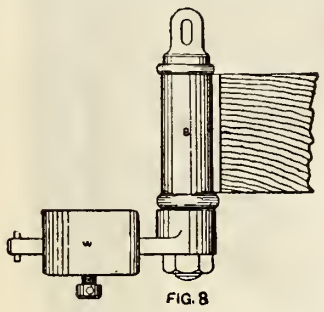


FIG. 8

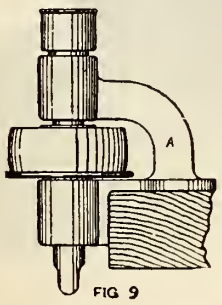


FIG. 9

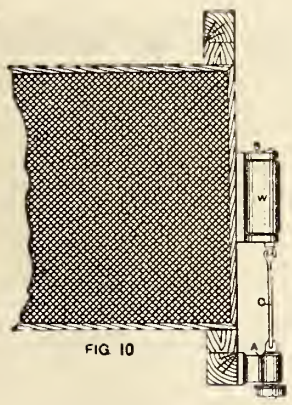


FIG. 10

It is common with most classes of machinery by which buildings are set in vibration to oppose the movement which the disturbing force tends to set up by the inertia of very heavy foundations; but there is the objection to this that the wear of the bearings of the machinery is greater than it would be if it were possible to obtain perfect balance of the moving parts. The system is, moreover, sometimes not successful, even very heavy foundation work failing to prevent the vibration of buildings. The models and diagrams herein referred to show that, in many cases, this may be obtained, and it will have been seen that this is done by permitting the main parts of the machine to move through a range which is precisely in proportion to the disturbing force and the thing which it disturbs. In many cases where the whole of the disturbing force cannot be thus utilized, the absence of perfect balance may be rendered harmless by permitting motion through small range in that which experiences first the effect of that want of balance; and, in general, it may be said that undesired vibration is the result of opposing a force which can either be avoided, by proper balancing of machinery, or prevented by permitting a small range of movement in that machinery instead of endeavoring to hold it absolutely motionless. It is a matter of common knowledge that engine drivers and engineers on many of the old steamboats were in the habit of allowing their holding-down bolts, and sometimes others, to be loose purposely, because by this the shaking of the boat was observed to be less, though the reason given was that the engine ran more smoothly.

In balancing steam engines the difficulties connected with the balance of reciprocating parts by rotating eccentric weights are complicated by the fact that different rotating unsymmetric parts lie in different planes, but it has been shown by Mr. Yarrow, among others, that considerable relief may be obtained by eccentric weights opposite the cranks, after the manner of those shown in Fig. 1, but although the effect of the reciprocation of the piston and connecting rod may be thus eliminated, the eccentric weights set up vibration in a direction transverse to the line of reciprocation. Mr. Yarrow has also gained good results with small engines, by opposing the vertical motion that would otherwise occur, by the inertia of what he has termed bob weights. These have, however, the disadvantage that they have to be operated by eccentrics which are not frictionless. Such weights, however, might be used, working horizontally in conjunction with the balance weights on the crank, but so operated that their inertia would be opposed to the horizontal movement which is set up by the eccentric weights on the crank shaft. In some cases engines of the marine form, instead of being fixed to a bedplate on the bottom framing, might be suspended near the bottom of the cylinders, by framing which would permit motion through a small range, and when we consider how small that movement need be, it is not improbable that connecting the crankshaft with the screw propeller shaft by couplings such as those used in the French navy, the vibration might be entirely avoided. This may be explained, by reference to diagram (Figs. 11 and 12), which represent a

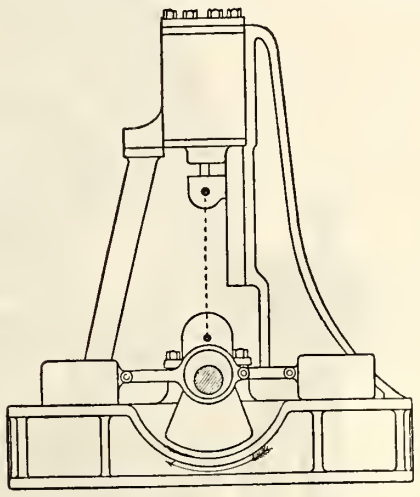


FIG. 11

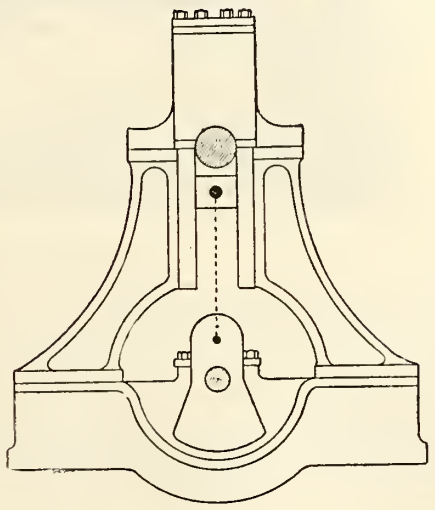


FIG. 12.

vertical engine, with the crank, connecting rod, and piston balanced, as against vibrating motion in a vertical direction. The same motion is not, however, balanced, or, rather, prevented, in the horizontal direction, but may, in such cases, be aggravated by the excess of the weight, D, over that necessary to balance the crank, the piston, and about half the connecting rod. In many cases, it would introduce practical difficulties in connection with the steam pipes if the engine were allowed to move horizontally, as suggested; but when this is the case, the engine may be fixed, and a weight or weights, W, be moved by an eccentric in a horizontal direction. This would neutralize the vibratory tendency; the weights would not be very large, and may be easily predetermined. The diagram, Fig. 12, shows the engine carried by a large trunnion shaft. Assume that the engine represented by Fig. 11 weighs say two tons, and that it is balanced as to vertical forces by the weight, D, and that this same weight is say 200 pounds greater than is required for the balance of the forces set up by the parts moving horizontally; then the horizontal movement of the engine, which might be set up by this excess weight, would have a range of half an inch. But if we make the excess weight move something as indicated by the sliding or suspended weights, W, shown on Fig. 11, then the vibrating tendency may be practically eliminated by using two weights of 400 pounds, having a stroke of 3 inches. On the other hand, if the engine be suspended as in Fig. 12, and the weight on which the effect of the eccentric weight of 200 pounds can be expended be one ton, then the swing opposite the crank will be one inch.

Model E is intended to illustrate the fact that piers of bridges which, during construction, have been loaded with weights considerably greater than those they are intended to carry, have been known to settle afterward, under the influence of vibration caused by passing trams. The model, E, represents a small weighted pier, standing in a box of granular material, into which it does not sink, although loaded. Upon setting up vibration of very small range, by means of a vibromotor on a horizontal axis, the pier immediately and rapidly sinks into the material.

As further illustrations of some points in connection with the vibration of buildings, a model is exhibited which shows how vibration, set up by machinery in one part of a building, may give rise to vibration of very different intensity and degree in different floors of that building, and how evidence afforded by two sets of observers may be contradictory and yet both perfectly true. Model F shows a number of superposed blocks intended to represent a small section of a structure such as a wall. When that upon which this stands is caused to vibrate, different parts of this column have very different ranges of movement.

Figs. 13 and 14 and model G are illustrative of the usual method of balancing a rotating thing, such as the armature of a dynamo or the drum of a thrashing machine. Fig. 13 may be taken as representing either of these resting on a pair of level knife edges which are commonly used for balancing purposes. When a drum is out of balance it will rest on these knife edges when the heaviest part, or the part most eccentric, is downward. To balance the drum, counterpoise weights are attached somewhere on a diameter opposite this heaviest part until the drum is indifferent and will rest wherever it is placed on the knife edges. This it will do even if the balance is effected by adding balancing weights at either A or A', Fig. 13, and for

FIG. 13.

a stationary thing this would be sufficient; but it is misleading for high speed machinery. It has been pointed out by Mr. G. Kapp, with reference to apparatus he uses for balancing dynamo armatures, that the added counterpoise must be in the same plane as the excess weight, which throws the armature out of balance, or each weight will act separately in setting up vibration by causing the structure of which it forms a part to endeavor to revolve round the center of gravity of the whole, which is not either at A or A' coincident with that of the shaft. With a view to the detection of the site of the eccentric weight throwing the whole out of balance, it is necessary to rotate it at a considerable speed, and in such a way that it is free to vibrate as it chooses. This can be done as shown in Fig. 14, wherein the armature, A, is placed in bearings,

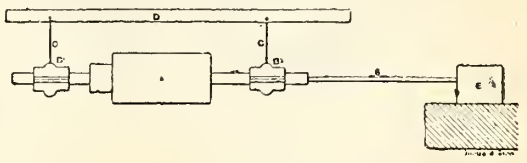


FIG. 14.

$B^1$ and $B^2$, carried by suspenders, C and $C^1$, the armature spindle being rotated by a flexible spindle, S' driven by a pulley at E. The bearings, $B^1$ and $B^2$, being free to swing, the amplitude of their movement will, either of them, depend upon the departure of the mass center of the spindle, and it can be seen whether the counterpoise is required at one or both ends.

The same thing may be found by suspending the armature spindle vertically from a vertical rotating spindle by means of a shackle and hooked rod. This is shown by the model, G, and the whirling apparatus to which it is attached. The same apparatus affords the means of showing, by means of a spindle and eccentric weight as used in the vibromotor, and shown in Figs. 5 to 9, how various may be the vibrations set up by a spindle rotating an unbalanced mass at different or varying speeds.

The fact that the wall model, F, moves is a proof that there is something connected with it that wants to move and we will not let it, or wants to move more than we will let it. Now this is bad policy, and the lesson to be learned from it is that, as we cannot stop the unbalanced thing from moving, we had better make our calculations afresh on the assumption that that fact must not be ignored, and that it must be allowed to move. It is no use trying to stop it, unless we give it something to expend its energy upon. We must let it move because we cannot help it, but we can help letting it move without taking toll. It is one of those "forces in nature which we must direct for the use and convenience of man," and in a general way it may be said that when a piece of mechanism wants to wobble, it is obviously either wrongly constructed, or if it is not and wants to wobble, then let it wobble, but make it wobble something you want wobbled. In most cases it will not wobble so much and never so forcibly if we don't try to stop its wobbling.

## APPARATUS FOR PREVENTING ACCIDENTS IN FACTORIES.

SOME time ago Mr. Charles Cambon invented an arrangement that permitted, through an electro-magnet whose armature acted more or less directly upon the cock of the steam port, of employing the power of a motor for immediately stopping it, and that too from any point of the works.

This arrangement, as simple as it was ingenious, had the inconvenience, however, of necessitating the intervention of an electric current, and, consequently, the installation of a dynamo or of batteries to furnish the energy at the moment desired—a complication which is slight, it is true, but which might sometimes suffice to cause a manufacturer to hesitate to pay the cost of the installation.

The inventor, seeing this difficulty, has devised another apparatus based upon the same principle, but in which the freeing of the counterpoise that puts the system in motion is obtained in a still simpler way, and without an electro-magnet, by means of an ordinary air cylinder. This apparatus, represented in Fig. 2, consists of a cylinder, A, in which moves a hollow piston, B, closed at one end and communicating at the other with a general air conduit, the ramifications of which, ending at different points of the factory, terminate in bulbs, G, or leather bellows, fixed to the walls. The base of the piston is provided with a projection, *h*, which is on a level with the underside of a lever, C, movable around an axis, *c*, and the short arm of which, beveled at the end, supports one of the arms, D, of a bent lever whose other arm is provided with a notch in which rests the hook-shaped extremity of a vertical rod, E, carrying the counterpoise. A pressure given one of the bulbs suffices to produce a

compression of the air in the conduit, and, consequently, the ascent of the piston, B, and the freeing of the bent lever.

In lieu of compressed air, rarefied air may be employed by slightly modifying the apparatus so that the starting may be effected through the descent of the piston instead of through its ascent.

In Fig. 2 we show the apparatus as applied to the control of a disengaging gear through the passage of the driving belt from the fast to the loose pulley. The shifting of the ungearing fork, K, is obtained, as in the case of the closing of the steam cock, by a toothed flywheel, I, which the descent of the counterpoise, P, causes to gear with a pinion, H, actuated directly by the motor.

In Fig. 1 is represented a certain number of other

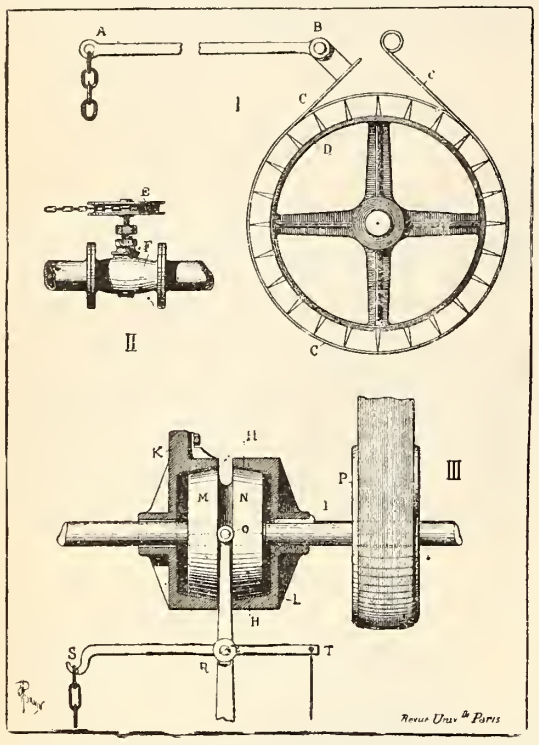



Fig. 1.—VARIOUS APPLICATIONS OF THE APPARATUS FOR PREVENTING ACCIDENTS IN FACTORIES.

applications of the apparatus. Thus, No. I. of the figure shows the system applied to the control of a brake, C, applied to a pulley, D, of wide diameter fixed to the main shaft of the engine or to the shafting that it is desired to effect the immediate stoppage of.

No. II. of the same figure shows the arrangement for the closing of a screw cock placed upon the main steam pipe.

Finally, No. III. shows a new arrangement of brakes devised by the inventor and which permits of effecting a quicker stoppage of the shafting than can be done with the ordinary brake.

The arrangement consists of a drum formed of two parts, M and N, in the form of truncated cones, united at their wide base and keyed to a transmitting shaft in two parts, one of which carries the driving pulley, P. These drums are inclosed in hollow cast iron disks, K and L, of the same form internally and provided with a rubber lining, H. The disk L is connected with the driving shaft, while the other, K, is bolted against the wall or a strong framework. In the position represented in the figure, the part of the shaft to the right revolves alone and without transmitting motion to the part to the left. If the starting bar, S T, be acted upon by pulling the cord attached to the extremity, T, the drum is made to move toward the right and presses against the lower edge of the disk, L, which carries it along. The throwing into gear is effected without shock, as in the analogous systems of friction coupling. But if, through an apparatus like that represented in Fig. 2, connected with the extremity *s*, of the rod, a shifting of the coupling box be effected from the right to the left, there will first be produced a disengagement and then immediately a wedging of the box in the disk, K, and, consequently, an abrupt stoppage of the transmission by a brake of a power greater than that of ordinary ones.—*Revue Universelle.*

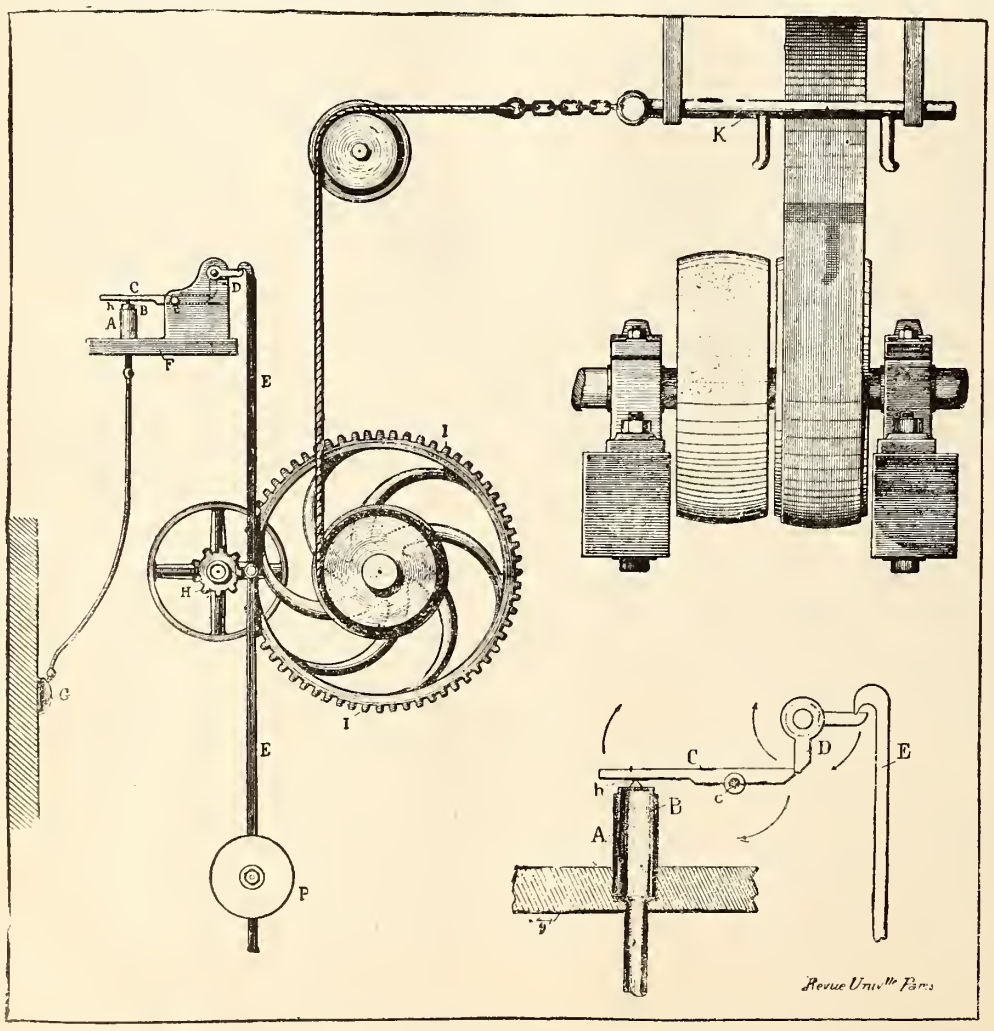
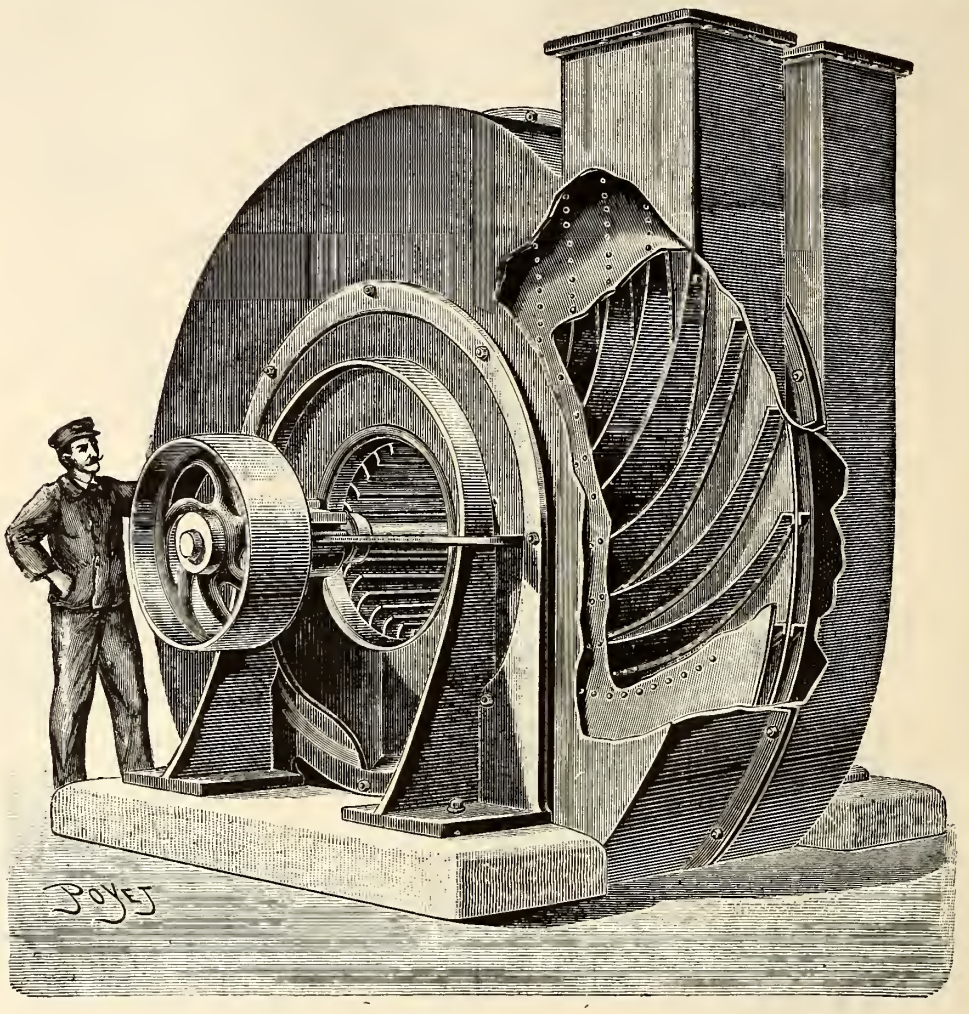



Fig. 2.—APPARATUS FOR PREVENTING ACCIDENTS IN FACTORIES.

## BLOWER FOR SMELTING ON A LARGE SCALE.

In consequence of the substitution of steel for iron, metallurgical works are transforming their old apparatus so as to obtain better and quicker results. In Belgium, especially, it is necessary to effect the smelting of iron very quickly. Very high cupolas of from 7 to 8 meters between the dead plate and the throat of the furnace, and of the small diameter of 0·9, 1 or 1·2 meters, are employed in many works.




BLOWER FOR SMELTING HOUSES.

With well conditioned cupolas, such as these, fusions of from 20 to 30 tons per hour are obtained. The fusion is very rapid, in consequence of the great height and the progressive heating of the layers of metal in measure as they descend upon the dead plate. By reason of such great height, it becomes necessary to employ very strong wind pressures. With a well calculated wind, conduits and tuyeres of a section proportional to the discharge and pressure, there is obtained a true puddling of the metal by the force of the wind, and the percentage of coke consumed is feebler—say about 4 kilogrammes per 100 kilogrammes of molten metal.

This great pressure necessitates special blowers. Mr. Farcot has constructed apparatus of this kind that easily give great volumes with such pressures.

In the apparatus illustrated herewith the turbine is 2·5 meters in diameter and the opening 0·62. The discharge is capable of reaching 6 cubic meters per second and the pressure 0·8 meter at 1 meter of water with a rotary velocity of 700 revolutions per minute. With this apparatus from 25,000 to 30,000 kilogrammes of metal per hour may be smelted. The apparatus runs without noise or vibration. The force of pressure (6 cubic meters) per second to obtain such a result is 100 horses of 75 kilogrammeters.

The very high pressure blowers consist of an iron plate turbine, the curve of the buckets of which is a logarithmic spiral of the force $\omega = \text{log. nat. } \rho$ or $\rho = \varepsilon^{\omega}$, in which the tangent makes a constant angle of 45° with the vector radius.

The bucket is inclined in the direction of the rotary motion. There is thus obtained an increase of centrifugal force for the same number of revolutions, in consequence of the velocity of circumferential impulsion of the molecules of the bucket.

The wind is produced at a pressure increasing exactly with the rotary velocity of the turbine.

The turbine revolves in a cylindrical jacket, and the annular space between it and the latter is so reduced that the pressure is the same in all the buckets and the air escapes laterally through two pipes without producing any vibration.—*Le Genie Civil.*

## FLOW OF SOLIDS.

Changes of form are very slow—though rapid enough to explain the motion of glaciers—but pressure increases their speed. Tresca, of the French Academy, has proved by his beautiful and varied experiments that under a certain pressure all solids "flow" like liquids, and that their molecules obey in such cases the laws of the motion of liquids.

A block of lead, or of steel, or of ice, placed in a cylinder and pressed upon, is made to flow out of a hole in the cylinder exactly as a jet of water. It remains a solid all the time, but its molecules, whose paths are rendered visible by a special arrangement, are seen to have acquired a certain freedom of motion, and to flow

in the very same way as molecules of water flow from a hole in a pail.

A cube of lead, steel, stone, or ice placed on a solid surface, submitted to a sufficient pressure or loaded with a sufficient weight, "flows" sideways just as if it were a block of plastic clay. The only difference is that clay flows under its own weight, while steel requires an immense pressure in order to "flow" in its solid state.

As to ice, it stands between the two—much nearer, of course, to the former than to the latter, if both are taken at ordinary temperatures. A thickness of a few hundred feet, or a corresponding load, would be quite sufficient to make it "flow," though remaining solid, even over a quite horizontal floor, and to behave in its spreading over the floor like a lump of plastic mud, provided its temperature is but a few degrees below zero. This is the net result of Tresca's epoch-making experiments on "the flowing of solids" under pressure, and these experiments have been fully confirmed as regards ice by the experiments of Helmholtz, Pfaff, and especially those of the Bologna professor, Blanconi. —*The Nineteenth Century.*

## RIDERS OF MANY LANDS.

THAT Colonel Dodge's latest work is of distinct military value would hardly be inferred from its title,* yet that is its *motif*, from the point of view of one reader.

One may be a horse lover and yet not familiar with the horse for war purposes. To him the red-white-and blue thread woven into this genuine "horse talk" is evidence that, in his trotting around the globe, Colonel Dodge's "heart was true to Poll," and that his patriotism never cooled a moment amid all the temptations of foreign lands.

One of the first things noted is the catholic spirit with which the subject of horsemanship is treated. Next to doctrinal questions there is no broader field for prejudice to disport itself in than in matters pertaining to the horse; his breeding, training and use—especially under the saddle. The author brings to his work practical experience among the various types of horses and riders described—not mere literary cleverness; and therein lies the value of the book as part of a cavalry library. Each chapter is devoted to a minute description and temperate criticism of the method of riding peculiar to one of a score of the principal countries of the world, with much interesting information as to the relative endurance under the saddle of various types of animals used—the horse, the ass, the camel and the bullock.

Among the more valuable chapters, in this respect, is that upon long-distance rides, in which Colonel Dodge, after due mention of some of the best performances of modern cavalrymen, truly shows that the professional *raison d'etre* for such experiments lies in the condition of man and beast for further work at the end of the ride.

Thus the late Austro-German long-distance race was a conspicuous and inexcusable display of cruelty to animals, without the slightest military advantage; and such also would seem to have been the result of the detail of a well-fed and high-spirited officer and charger to carry Emperor William's dispatch across country in the shortest possible time; the result of this experiment, if it has any value, tends to throw suspicion upon the condition of the German cavalry for an immediate test of endurance such as might be desirable in the event of war.

As a feat like that of the Oriental horse and rider of 950 miles in 45 days, may be mentioned the ride of Lieut. William P. Sanders, Second U. S Dragoons (afterward Brig.-Gen. U. S. V., killed at Knoxville), who, accompanied by a sergeant, set out at a moment's notice from Fort Crittenden, U. T., March 30, 1861 in pursuit of deserters, who were caught by him in the neighborhood of Los Angeles, Cal, and turned over at the nearest post for trial. Sanders and the sergeant immediately returned to their post, arriving there on May 31, with the same horses, in good condition, having covered a rough and dangerous route of 1,600 miles in 59 days. Sanders' mount—an average American horse—was used as an officer's charger for four years during the civil war, and fell mortally wounded within the Confederate lines at Winchester in 1864.

The book is unique in its combination of what may be termed professional data with popular literature. Sound horse-sense is deftly intermingled with light gossip on men and things from a globe-trotter's standpoint. It is civil as well as military; it discusses sport in a Frank Forrester vein, and treats of arms and accouterments of military uniform and mufti; with respectful comments upon the fair equestriennes of Egypt and Hawaii and the utility of the divided skirt. The author does not lack audacity, going so far as to find fault with Phidias and to intimate that there are limits to British horsemanship.

If there are deficiencies in this work, they are of a character easily supplied—at least in another edition. The most serious one (and for this the publisher should share the blame) being the want of a table of contents. The illustrations are numerous, artistic and well printed.

A quotation from the closing chapter of this charming volume reads thus:

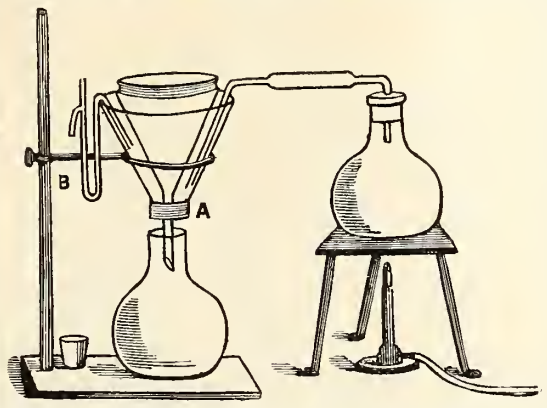
"But after passing in review the 'Riders of Many Lands,' when I again set foot on shore in the United States I could not but feel that this country of ours is the home *par excellence* of horsemen. This idea is not, I think, bred solely of national pride; my readers will surely absolve me from narrowness or provincialism in the matter of equitation, or from any set scheme to rob other nations of their due. I am happy to admit, for it is manifestly true, that the best sportsman in the saddle is the Briton. On the other hand, the German is as far and away ahead of him in military riding—that is, in the drilling of bodies of horse—as the Frenchman is ahead of him in the niceties of breaking, training and *manege* riding. Where to place the Arab it is hard to say With all due respect to the man or the race that produced the original strain of blood on which we all rely for our speed and endurance, I do not think that the best Arab is as good a rider as the best European or American; while the average Arab is, in efficiency, far below our riders under parallel conditions. The Cossack makes, no doubt, the best half-barbaric light cavalry in the world, and in his element is hard to equal. But after all it must be allowed that in some matters equine we Americans are pre-eminent. I will venture to claim that in distance riding, which is perhaps the very highest form of horsemanship, we Americans are quite unapproached. Added to all this, the fact that we have enriched the world with a brand new type in the trotter, and that in racing and in polo and hunting we are fast catching up with our English cousins; and while I do not wish to 'claim everything,' I think—to recur to my original word—that it must be 'allowed' that in all-round ability to breed, train and ride the horse to the very best advantage, the American is *primus inter pares.*" So say we all of us.—*T. F. R., in the Jour. of the Military Service Institution.*

* "Riders of Many Lands," by Theodore Ayrault Dodge, Brevet Lieut.-Col. U. S. A. Harper Bros., New York. 1894.

## HOT WATER FUNNEL.

I HAVE lately constructed a simple form of hot water funnel which, I think, is better in some respects than the ordinary copper-jacketed funnel usually employed for filtering liquids which require to be kept hot during the process. It consists of two glass funnels fitted one inside the other by an India rubber plug, A, on the neck of the inner funnel, around which the outer funnel fits as a collar. The top of the inner funnel projects somewhat in order that the filtering liquid may be conveniently covered. The interspace contains water, which is kept hot by blowing steam into it, and the excess of water thus formed is carried away by a constant level siphon, B; a strip of wet tape hanging over the edge of the outer funnel answers the same purpose.

The chief virtue of this kind of hot water funnel lies in the fact that it can be constructed in a few minutes out of ordinary laboratory apparatus at a very small cost; but it has a second advantage, for by employing steam to maintain the temperature instead of the naked flame generally used with the copper-




jacketed funnels, all risk of inflammable vapors from spirituous and other liquids becoming ignited is avoided.—*Charles R. Beck, in Chemical News.*

## ANCIENT EGYPTIAN PIGMENTS.*

THE red pigment used by the Egyptians from the earliest times is a native oxide of iron, a hematite. Most of the large pieces found by Mr. Petrie are an oolitic hematite. One specimen on analysis gave 79·11 per cent. and another 81·34 per cent. of ferric oxide. The pieces to be used as pigments were no doubt carefully selected, and the samples that I have examined, mostly from Gurob and Kahun, are very good in color. All the large pieces were of a singular shape, having one side smooth and curved; and in all cases this side was strongly grooved with striæ, giving somewhat the appearance to the mass of its having been melted, and allowed to cool in a circular vessel. No doubt the explanation of this smooth curved surface is, that these pieces had actually been in part used to furnish pigments, and having been rubbed with a little water in a large circular vessel, had been ground to this shape. By experiment it was found that these pieces of the native hematite yielded, without any further addition by way of medium, a paint which could readily be applied with a brush, as it possesses remarkable adhesive properties, and it resembles exactly, in every particular, the red used in the different kinds of Egyptian paintings. In addition to these samples of the pigments, all of which are native minerals and in their natural conditions, there are other reds, finer in color and smoother in texture, evidently a superior pigment; these apparently have been made from carefully selected pieces of hematite, which have been ground and washed, and dried by exposure to the air. Some of these pieces are very fine in color, and it would be difficult to match them with any native oxide of iron that is used as a pigment at the present day. There is every reason to believe that this is the earliest red pigment which was used, and it remains to this day the commonest and most important one: it is a body unattacked by acids, unchangeable by heat, and even moisture and sunlight are unable to alter its color. At the present time many artificial products are used to take the place of this natural pigment.

*Yellow Pigments.*—These, again, are natural products, and by far the most common yellow used by the Egyptians is a native ocher. These ochers consist of about one-quarter of their weight of oxide of iron, from 7 to 10 per cent. of water, and the rest of their substance is clay. When moist they have a greasy feel, and work smoothly and well with the brush. There is no evidence of these bodies having changed color, but undoubtedly they are chemically not nearly so stable as the red form of oxide of iron. Many of the pieces of this pigment, found at Gurob and at Tel-el-Armarna, are very fine in color.

Some of the specimens of the very earliest colors of which the exact history is known appear to be an artificial mixture of these two colors, the red and yellow, thus producing an orange color. These samples were found on a tomb at Medum, which, according to Prof. Flinders Petrie, was built by Nefermat, a high official and remarkable man at the court of Senefru. Senefru is known to have lived in the fourth dynasty, about 4000 B. C., and to have preceded Khufu, the Cheops of the Greeks, who was the great pyramid builder. Now, on Nefermat's tomb the characters and figures are incised and filled in with colored pastes, which I have been able to examine, and it is of interest to know that this use of color was a special device of Nefermat, for on his tomb is stated that "He made this to his gods *in his unspoilable* writing." In this unspoilable writing the figures are all carefully undercut, so that the colored pastes, so long as they held together, should not be able to drop out. All the pastes used are dull in color, consisting entirely of natural minerals. Hematite, ocher, malachite, carbon, and plaster of Paris appear to be the materials used. Chessylite, as a blue, probably was known even at that date, but the artificial blues seem hardly at this period to have come into use; certainly they are not found in the specimens of the Nefermat colors which I have examined. Another yellow pigment, far brighter in color, was also often used. It is a sulphide of arsenic, orpiment; it is a bright and powerful yellow, again a body found in nature, but a much rarer body than ocher, and consequently, probably was only used for special purposes, when a brilliant yellow was required. As far as it is known at present, this pigment did not come into use until the eighteenth dynasty. Gold might even be placed among the yellow pigments, for it was largely used, and with wonderfully good effect. Its great tenacity seems to have been fully recognized, for gold is found in very thin sheets, and laid on a yellow ground, exactly as is done at the present day.

These pigments are then simply natural minerals, no doubt carefully selected, and sometimes ground and washed previous to being used; but the blue color which is so largely used by the Egyptians is an artificial pigment, and consequently has far more interest attached to it than those already mentioned. It is a body requiring considerable care and experience to make, and thus its manufacture enables us to some extent to judge of the knowledge and ability which its producers had of carrying on a chemical manufacture. No doubt the splendid blue of the mineral chessylite was first used, but certainly in the twelfth dynasty—that is, about 2500 B. C.—these artificial blues were used. They are all an imperfect glass, a frit, made by heating together silica, lime, alkali and copper ore.* The number of failures which may have occurred, and how much material may have been spoilt, cannot be known, but all blue frit which I have examined—and it is a considerable amount, some being raw material, lumps as they came from the furnace, and the rest ground pigment—all has been, though differing in grain and quality, well and perfectly made. Now this implies that the materials have been carefully selected, prepared, and mixed, and that definite quantities of each were taken, this necessitating the careful measuring or weighing of each constituent—an early application of the fundamental law of chemistry, combination in definite proportion. The amount of copper ore added determined the color; with 2 to 5 per cent. they obtained a light and delicate blue; with 25 to 30 per cent. a dark and rather purple blue; with still more the product would be black; if the alkali was too little in amount, a non-coherent sand resulted; if too much, a hard stony mass is formed, quite unsuitable for a pigment. The difficulties, however, did not by any means end with the mixture of the materials. For the next process, the heating, is a delicate operation. Unfortunately up to the present time the exact form of furnace in which this operation was carried on is not known. The furnaces were probably, especially after use, very fragile structures, and have passed away. Considerable experience in imitating these frits even when using modern furnaces has taught me that the operation is really a very delicate one; the heat has to be carefully regulated and continued for a considerable length of time, a time varying with the nature of the frit being prepared; and, further, in the rough furnaces used it must have been specially difficult to have prevented unburnt gases from coming in contact with the material; but if they did, a blackening of the frit must have taken place. However, all these difficulties were avoided, and a frit was made which exactly answered all the necessary requirements. It had, for instance, the right degree of cohesion, for many of the large pieces which have been found have, like the hematite, a smooth, curved striated surface, and on rubbing in a curved vessel with water, easily grind to powder.

The powder is naturally much less adhesive than the hematite powder, but on adding a little medium, it could at once be used, without other preparation, as a paint. Some of the pieces vary in color in different parts. This may have arisen from imperfect mixing, or from some parts of the furnace being hotter than others. It hardly appears to be intentional; possibly some of the dark, purplish colored frits were produced by accident; large pieces of it have as yet, I believe, not been found. By means of comparatively small alterations these frits could be obtained of a green color. One way was by introducing iron. If, for instance, the silica used was a reddish colored sand, it gave a greenish tinge to the frit; and frit made with some of the ordinary yellowish desert sand was found to give a frit undistinguishable from the most common of the old Egyptian frits. Again, a rather strong green color is obtained by stopping the heating process at an early stage, this green frit simply on heating for a longer time becoming blue. Another way in which even the strong colored blue frits have been converted into apparently green pigments is by their being coated over with a transparent but yellowish colored varnish which has to a remarkable extent retained its transparency, but no doubt become with age more yellow, and although strongly green now, may very likely originally have been nearly colorless, and consequently the frit was then seen in its original blue color. Even as early as the twelfth dynasty the green frits used were dull in color, and if by chance a brighter green was required, then they used the mineral malachite.

* A lecture delivered at the Royal Institution of Great Britain, on March 17, 1893, by Dr. William J. Russell, F.R.S.—*Nature.*

* A sample of the pale blue frit gave, on analysis, the following results:

| | |
|---|---|
| Silica | 88·65 |
| Soda | 0·81 |
| Copper oxide | 2·09 |
| Lime | 7·88 |
| Iron oxide, alumina, etc | 0·57 |
| | 100·00 |

No doubt by far the most brilliant blue used at any time was selected and powdered chessylite, and even down to the twenty-first dynasty they seem to have made use generally of somewhat brilliant colored frits; but after that time more subdued colors appear to have been used, and even the scarabs were made of a much duller color than formerly. All these blue frits form a perfectly unfadeable and unchangeable pigment. Neither the sun nor acids are able to destroy or alter their color.

The only other pigment to which I can refer this evening is the pink color, which in different shades was much used. This is again an artificial pigment, and belongs to an entirely different class from any of the foregoing ones, for it is one of vegetable origin. On simply heating it, fumes are given off and the color is destroyed, but a large white residue remains; this if sulphate of lime. It may here be stated that the white pigments used sometimes were carbonate of lime, but more generally sulphate of lime in form of gypsum, alabaster, etc. This substance is often very white in color, is very slightly soluble in water, and has a singular smoothness of texture, which makes it work well under the brush; and in addition to these qualities, it is a neutral and very stable compound; so is well fitted for the purpose to which it was applied. It was easily obtained, being found native in many parts Egypt. It is also interesting to note that there is an efflorescence consisting of this substance which frequently occurs in Egypt, and is of a remarkably pure white color; probably this was used as a superior white pigment. It was easy to prove then that the pink color was gypsum stained with organic coloring matter, and to try and imitate the color appeared to be the most likely way of identifying it. Naturally, madder, which it is known has from the earliest times been used as a dye, was the vegetable coloring substance first tried, and it answered perfectly, giving under very simple treatment the exact shade of color to the sulphate of lime which the Egyptian pigment had. Essentially the same coloring matter may have been obtained from another source, viz., Munjeet. In the case of madder it is interesting to note that the color is not manifest in the plant—the *Rubia tinctorum*—for it is obtained from the root, and is even not ready formed there. In the root it exists as a glucoside, and this has to be decomposed before the color becomes manifest. In this root there exist several coloring matters, which are known as madder red, madder purple, madder orange, and madder yellow. On breaking up the roots and steeping them in water for some length of time, the colors come out, some sooner than others, so the tints vary. Again, changes of color are easily obtained by the addition of very small quantities of iron, lime, alumina, etc., so that in these different ways a considerable range of colors could be obtained, but a delicate pink color was the one probably generally made. This color is easily obtained by simply stirring up sulphate of lime in a tolerably strong solution of madder, and adding a little lime, taking care to keep the coloring matter in excess; the coloring matter adheres firmly to the lime salt, and this settles on to the bottom of the vessel; the liquid is then poured off and the solid matter, if necessary, dried, or mixed, probably with a little gum, and used at once without other preparation. That the coloring matter was really madder could also be tested by another method, viz., by means of spectrum analysis. Both the madder red (alizarin) and the madder purple (purpurin) give, when the light which they transmit is analyzed by the prism, very characteristic absorption bands; the purpurin bands are the ones most easily seen; consequently it became a point of considerable interest to ascertain whether from a specimen of this pigment, some thousands of years old, these absorption bands could be obtained. A small sample of this pink pigment was taken from a cartonage which was exhibited, and by treating it with a solution of alum, the color was thus transferred to the liquid, and by throwing the absorption spectrum which it gave on the screen, and comparing it with the spectrum from a madder solution, it was clearly seen to be identical.

Many specimens in imitation of different colored frits, and a large copy of a cartonage colored with pigments prepared by the lecturer, were exhibited.

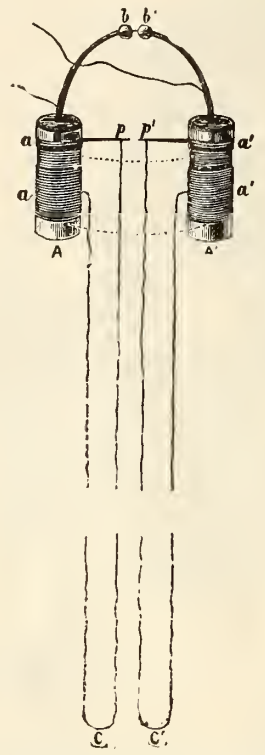
## SPEED OF PROPAGATION OF AN ELECTRICAL DISTURBANCE.

An ingenious method of determining the rate at which an electrical disturbance is propagated along a copper wire was recently described by Mons. R. Blondlot before the Paris Academy of Science. The method is particularly interesting, since it possesses the advantage of being independent, not only of any theory, but even of the existence of electro-magnetic oscillations and undulations.

The apparatus is simple, and the special feature is shown in the accompanying figure. Two condensers, A and A', in every respect similar to each other, are formed each of a cylindrical lamp chimney coated within and without with tin foil. Each of the two external armatures is divided into two annular parts, the one insulated from the other, namely, $a$ and $a_1$ in the case of condenser A, and $a'$, $a_1$ in condenser A'. The internal armatures are respectively connected up to the terminals of an induction coil, the wires being joined to the curved brass rods shown in the figure, which are in connection at one end with their respective armatures, and at the other end with the ball, $b$ or $b'$. Between $b$ and $b'$ there is a gap of from 6 to 8 mm. From $a$ and $a'$ branch out toward each other two short horizontal pointed brass wires, $p$ and $p'$, and separated by a distance of 0·5 mm. To $a_1$ and $a'$ are respectively connected the copper wires, $c$ and $c'$, each 1,029 m. long, 3 mm. diameter, and terminating as shown in the figure at the points, $p$ and $p'$. The dotted lines indicate the positions of damp threads, by means of which the two exterior armatures are connected electrically.

The discharge of the condensers is effected by a spark passing between $b$ and $b'$. At this moment the charge on the external armatures is set free, and a difference of potential is suddenly set up between $a$ and $a'$ on the one part and between $a_1$ and $a'_1$ on the other; the damp threads do not play any part at this moment on account of the extreme rapidity of the phenomena. The armatures, $a$ and $a'$, are discharged by a spark passing between the points, $p$ and $p'$; similarly the armatures, $a_1$ and $a'_1$, which are connected to the same points by the long wires, $a_1$, $c$, $p$; $a'_1$ $c'$ $p'$ are discharged by a spark between $p$ and $p'$, taking place subsequently to the first, since the disturbance has to travel a distance of 1,029 m. The interval of time between the first and second sparks, between the points, $p$ and $p'$, is the time taken by the disturbance to travel the distance along the copper wire, and to determine the speed of propagation it suffices to measure the interval, since the distance is known. Mons. Blondlot effected this by concentrating the light from the spark by means of a concave mirror movable around an axis parallel to $p$, $p'$, and received on a vertical screen the doubled image of the spark. Given the speed at which the mirror is spun round, its distance from the screen, etc., the rest becomes a matter of simple calculation. A photographic plate may be substituted for the screen.

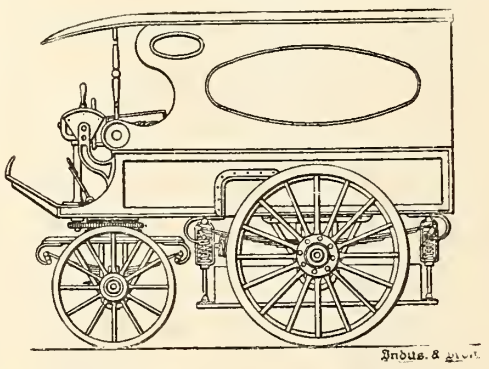
The results of fifteen experiments gave a mean speed of 296·4 kilometers per second. A set of experiments




made on a wire, 1,821·4 m. long, gave a mean value for the speed of 298 kilometers per second. The approximate equality of these values, obtained on lines of different lengths, shows that the movement of propagation is fairly uniform, and the numbers found are in accord with those previously obtained by another method by Mons. Blondlot.

## ELECTRICALLY PROPELLED VEHICLES FOR ORDINARY ROADS.

Electrical vans and omnibuses are now being run on demonstration journeys by Messrs. Clubbe & Company, Elm Street, London. The illustration which we subjoin gives a general side view of the electrical parcel van of the latter firm, on which we have recently had the opportunity of making a trip through some of the most crowded London streets. It resembles an ordinary two-horse van without shafts. The current is supplied by E. P. S. accumulators hung below the body of the vehicle; these with one charge can propel it 50 miles at any desired speed up to ten miles an hour, and when run down can be changed for a fully charged set in a couple of minutes. The steering is said to be very easy and satisfactory, and is managed from a wheel worked by the driver's right hand. The motor oc-



cupies a small part of the interior, which is lighted by two electric lamps. It is stated that this van can be run and maintained at about half the cost of one of the same size drawn by horses.

## FISH POISONS.*

By J. B. Nagelvoort.

Fish poisons are remarkable substances. As far as known, they belong partially to the alkaloids, in part to the glucosides. Many are saponin-like bodies, but our knowledge of a great many of them is *nil*.

The best known are the berries of different species of cocculus (fishberries in English, Fischkorner in German), which certain classes of people in Europe and Asia regularly employ to catch (poison) fish. But among the more cultivated classes the knowledge of this craft seems to have been lost. The unripe or ripe berries of the cocculus are rubbed to a pulp, and this pulp is simply thrown into the water, whereupon the fish become semi-intoxicated, rise to the surface and are easily caught.

There is always some risk connected with the use of these berries, and where a government does its duty it is strictly prohibited to sell fishberries; but fish caught with any one of the many other fish poisons are usually harmless as food for man. This is in itself not so remarkable, inasmuch as we often meet cases of the converse—animals partaking with perfect impunity of plants which contain poisons deadly to human beings. Furthermore, the fatal dose for a fish is usually—not always—too small to harm man.

The inhabitants of Ceylon have the dangerous custom of using the very poisonous fruit of Hydnocarpus venenata, Gaertn., to poison the rivers. But to eat the fish caught involves great risk to human life.* This is no occasion for wonder, since we learn from Greshoff that he found $HC_2N$ in an oil derived from the plant.

As evidence that the knowledge of catching fish by poisoning them wholesale seems to have been lost among the more civilized portions of society, or is not widespread—proof that half of the people do not know how the other half live—I may cite the fact that the Encyclopædia Britannica, in an elaborate article on "Fisheries," does not give any information on our subject.

If the use of certain fish poisons is attended with risk, not so with the bark of Zanthoxylum scandens, Bl., a plant found in tropical Asia and Australia. The bark is pounded to a pulp; this is thrown in the water; presently the fishes are seen on the surface dead. They can be eaten, however, with perfect impunity.

The bark of Walsura piscidia, Roxb., as the name of the plant indicates, has some connection with fish and fisheries. It is a plant of British India, Malabar, and Ceylon. The bark is thrown into ponds to kill fish, which, coming to the surface, are easily taken and are not considered injurious as food.

From Serjania lethalis, St. H. (many Serjanias bear a suspicious name—S. noxia, S. inebrians), the fresh branches are used in Bolivia to poison the rivers; and Weddell (*Voyage en Boliv.*, 1853, 449) states: "I am informed that fish thus caught do not cause any inconvenience when eaten."

The bark of Paullinia pinnata, L., a plant growing anywhere in (tropical) Brazil, Mexico, Guiana, the Antilles, and equatorial Africa, is used in Brazil to poison the watercourses, and the fish thus caught are harmless as food.

Tephrosia Vogelii, Hook., furnishes the fish poison *par excellence*. A French African traveler, M Griffon du Bellay, states: "Nothing so easy as to 'fish' with this plant. I have seen them take a few handfuls of leaves only, throw them in the water, and all the small fish came immediately to the surface, dead. Soon after a kind of lamprey came gasping for air and was easily caught. The fish tasted excellent." (*Adansonia*, vi., 225.) Col. Grant collected the plant in 1862, in the country between the Albert and Victoria Nyanza lakes, and wrote: "A mash is made of this plant by the natives to kill fish. The mash is thrown into the water; the fish float to the surface dead and are taken for food." (*Transact. Linn. Soc.*, xxix., 55.)

Of another Tephrosia, found in the South Sea Islands (T. piscatoria), different authors tell us that the brauches and leaves, thrown into the water, kill the fish without thereby rendering them unfit for consumption by the natives. (De Lanessan, Hillebrand.)

This is one of the most remarkable features of fish poisons: that they act in dilutions containing an amount of the poisonous principle too small to be detected by chemical reagents. It has, therefore, for quite a while been the custom in analytical laboratories to submit fishes to the same experiments as are made on warm-blooded animals, when properties of newly discovered active principles from plants, or what are considered to be active principles, are to be studied. Prof. Plugge (Groningen, the Netherlands) mentions (*Arch. f. Exper. Pathol. u. Pharmacol.*, xxxiii.) that a gold fish of 25 g. died in water containing only $\frac{1}{200000}$ of its volume of a new alkaloid that he had under investigation (Pithecolobin).

It is greatly to the credit of Dr. Greshoff (of late, chemist to the Botanical Gardens at Buitenzorg) that he used the unsurpassed facilities at his command in the library of the garden, and brought together in one book (from which the above is extracted) what was previously scattered throughout general literature. This work deserves our praise all the more, as we yet bear fresh in our memory the wealth of suggestions and of original discoveries which he poured out from the treasury of the flora of the Malayan Archipelago in his first report from his laboratory.† Standing as apothecary on the borderland between the professional botanist and the chemist *sui generis*, devoted to science for its own sake, a fluent writer and accomplished scholar, he has given us a monograph of which we may say that no other like it exists.

At the author's request I have the honor and the pleasure of introducing it to an English-speaking public; for, to my regret, it is written in Dutch. But as Greshoff, when I called his attention to this disadvantage, responded that any one once interested in the present subject would find out his work, I have no further ground for objection. Every reader will acknowledge that Greshoff did not serve "toujours perdrix" in his intellectual bill of fare. The author himself invites a statement of the experience of others—to which request I call the attention of the United States Fish Commission.

We must be astonished at the insignificant part analytical chemistry has played in developing our knowledge of the nature of fish poisons. On general principles it is not to our discredit that savages caught fish by intoxicating them, long before we had the least idea of such methods. They had arrow poisons too (curare) of which we knew very little until lately. We *fin de siecle* people live too artificially and are little in touch with nature. But that Greshoff's monograph quotes poisons of which most of us (I for one) never heard is humiliating.

His index shows 233 plants. One other book on the same subject, in the Spanish language, by Ernst, published in Caracas, South America, in 1881, enumerates

* "Beschrijving der giftige en bedwelmende planten bij de vischvangst in gebruik, door M. Greshoff. Batavia Landsdrukkerij. 1893." The address is that of the printer. The book is not for sale. A few copies will be offered to colleges of pharmacy in this country.

* Baillon, *Histoire d. Plantes*, vi., 299.

† *Ein Laboratorium f. Pflanzenstoffe*, by Prof. Th. Husemann, *Pharm. Zeit.*, ii., February, 1891, p. 93.

sixty plants only as containing fish poison. Another book, written by Radlkofer, in German (*U. Fishvergiftende Pflanzen. Sitz. ber. d. Math. Phys. Classe d. K. Bay. Akad. d. W.*, Bd. xvi., 1886), contains 154 names.

Greshoff has very judiciously furnished such long quotations that we are enabled in many cases to judge for ourselves respecting the merit of the statements. This makes the "Monografia" much more instructive than it would have been if we were referred to the original papers. I think that even a reader unfamiliar with the Dutch language will be largely benefited by a perusal of Greshoff's book, since so many quotations are in French, in German, in English, or in Latin, and we all understand the botanical system he followed (Bentham and Hooker's Genera Plantarum) and the abbreviations used.

I do not doubt that my opinion of the utility of the "Monografia" to our growing generation of pharmacists will find opposition. But it seems to me that if they will cultivate, every one according to his own taste and ability, the field here indicated, they can make their influence in science felt, and that it will give them strength to resist the destructive invasion of those purely mercantile interests which would cheer fully wipe out pharmacy, pharmaceutical chemistry, and plant investigation, and make of the possible lover of science a mere automatic salesman.

The experience with fish poisons is not an imaginary one. It rests upon a basis of true physiological experiments.

The "Monografia" gives more than its title calls for.

Of Zizyphus vulgaris, Lam., we read: "The leaves when chewed are said to destroy the power of the tongue to appreciate the taste of disagreeable medicines." (Pharmacographia Ind., i., 350.)

Tephrosia toxicaria, Pers., is said to serve as a substitute for digitalis.

Indigofera Anil., L.—A decoction of the indigo root, used as a lotion, effectually destroys vermin.

Erythrina aurantiaca, Ridley.—Three or four seeds, being ground and mixed with food, will kill any dog or cat that eats it. A warm infusion of the inner part of the bark is used in toothache.

Derris elliptica, B.—The roots of this plant, steeped in water, afford a useful insecticide for gardening purposes. The Malayans use the bark as one of the ingredients in their Ipoh arrow poison.

Piscidia Erythrina, L.—It is stated that the tincture of the bark of the root is intensely narcotic. A decoction of the bark cures the mange in dogs.

Acacia Farnesiana, Willd.—Mad dogs are killed in Brazil with the seeds.

Albizzia amara, Boiv.—Its root contains 10 per cent. of saponin.

Begonia Rex, Putz.—The juice is poisonous to leeches, and may therefore be used to kill them when found in the nostrils of animals.

Hydrocotyle vulgaris, L., kills sheep when they eat the plant.

Hydrocotyle umbellata, L., is used in Mexico medicinally (emetic?) A study of the plant is very much to be desired.

Annagallis arvensis, L., kills cattle and horses when they eat the plant.

I close my review with Verbascum, L. Chemistry knows nothing of a toxic active principle in any Verbascum. Verbascum species are used in Spain, Italy, and Greece, not only as a fish poison, but also to destroy mice.

The mulleins (Verbascum) approach digitalis, says Lindley (The Vegetable Kingdom, 3d edit., 1853, 683). And our highest authority in the history of medicinal plants, Prof. F. A. Fluckiger, does not doubt that the plant to which this property is attributed is indeed a Verbascum. Prof. Husemann, in introducing the "Monografia" to German readers, in the *Pharm. Zeitung*, 23, xii., 1893, recalls the fact that Verbascum Blatteria is known to have killed sheep.

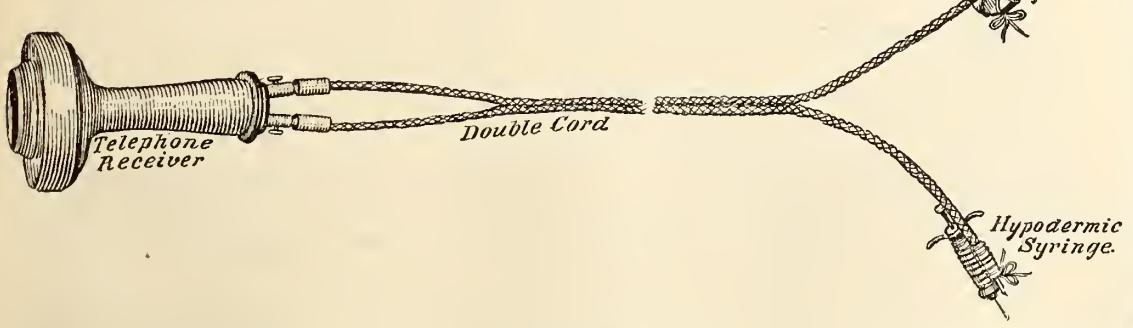
May Greshoff's "Monografia" kindle a worthy enthusiasm for the advancement of pharmacy in its legal collateral branch, toxicology.—*Bulletin of Pharmacy.*

## LOCATING METALLIC BODIES IN THE UPPER AIR PASSAGES.

By E. N. Heard, M.D., Sandusky, O., Assistant Surgeon, Ohio State Soldiers' Home.

In the *Medical Record*, December 16, 1893, page 798, Dr. J. Mount Bleyer described a method of obtaining a lost intubation tube lodged below the vocal chords. He did this successfully by means of a battery, electric bell, and surgical probe en circuit, the latter consisting essentially of two needles in a handle, across which closure of the circuit was made by the contact of both needles with the lost body at the same time. He considers the instrument simple, and, indeed, it is both simple and ingenious. But the one I wish to offer is much simpler.

Should there be a telephone in the house, take down the receiver or ear trumpet, together with the attached flexible chord. To one of the free ends of the bifurcation attach the metallic part of your hypodermic instrument, binding it securely by means of cord. To the other fore end attach a piece of steel of convenient size to be placed in the mouth (the large blade of a pocket knife may be made to serve). Place the latter in the mouth and see that it is well in contact with the tongue. Then introduce the hypodermic needle through the tracheal wall, the telephone receiver being held to the ear meanwhile. Should the body be touched, even in the slightest degree, there will be a scratching sound in the telephone. The working of this instrument depends upon the well known fact that two metals of different kinds, when in contact with the fluids of the body, form a sort of battery which will give current sufficient to influence a telephone receiver. A blunt probe may also be used through the air passages. a piece of metal of the same kind being connected with the surface of the body and the telephone. Annexed I give a diagram of the two.




Just here it may be well to say that whatever of plating may be on the syringe, although it does probably make some current with the mouthpiece, yet it makes such a small amount that, being constant in quantity, it makes no practical difference.

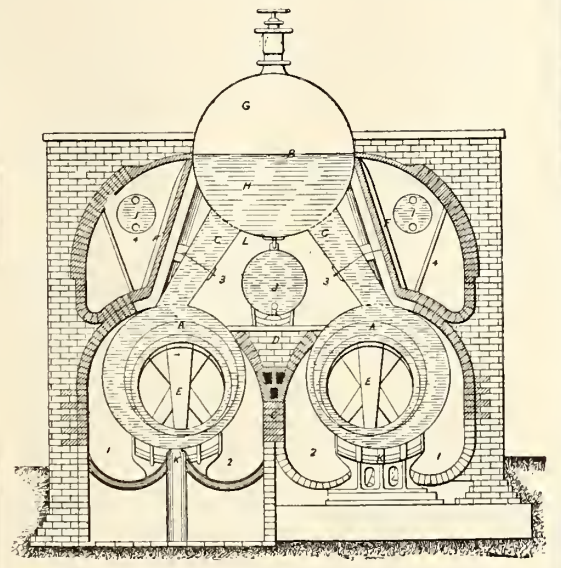
Better contact with the skin (in the second instrument) can be made by making the electrode of a silver dollar and moistening it with salt water or very dilute sulphuric acid.

The advantages of these instruments over that of Dr. Bleyer are three: 1. Little time is needed to arrange the apparatus. 2. The slightest contact will bring response. 3. There is not the least danger of injury.

In the instrument described by Dr. Bleyer, some ingenuity is needed to arrange the two needles, and both of them must be pressed firmly against the metallic object at the same time.—*Medical Record.*

## UTILIZATION OF TOWN REFUSE.

A special train recently left St. Pancras Station, London, conveying a party of gentlemen who had accepted the invitation of the directors of "The Atlas Contracting Syndicate, Limited." The object of the visit, says the *Engineer*, was to afford to the party an opportunity of witnessing the installation at Halifax of Livet's patented apparatus for the economical and rapid generation of heat in furnaces and the utilization of dust and refuse for electric lighting. It may be scarcely necessary to remind our readers that, with respect to processes of this description generally, there is nothing novel in the means employed to effect a certain object, or to obtain certain results of the following character: (1) The disposal of solid town refuse, whether wet or dry, by burning. (2) The utilization or the conversion of the products of the combustion of the said refuse into steam. (3) The employment of the steam so generated for electric lighting, as at Southampton and Nottingham, for pumping sewage, as at Batley, and for a variety of useful purposes, both at home and abroad. (4) The manufacture of a kind of cement or mortar out of the residue or by-products of combustion, or the use of them in combination with tar or bitumen for footpaths and flaggings; or again, the clinker can be utilized for the foundation or bottoming of ordinary roads.




The solid refuse of London and other large English cities, among which may probably be included Halifax, contains about 80 per cent. of mixed cinders and ashes, thus providing in a very great degree the materials for its own ignition and combustion. If we now take the case of the refuse of a large oriental city in India, it will be found to be absolutely devoid of all coal residue or cinders, and to be mainly composed of stable litter, vegetable matter, cattle droppings and a proportion of kitchen refuse, street sweepings and other general rubbish. At certain seasons of the year the whole mass becomes so exceedingly soft and saturated with moisture as to be practically incombustible in a furnace designed for the burning of Continental town refuse. Of all the ingredients, vegetable matter in a wet condition is the worst. It lies so closely that, without some special contrivance for insuring an efficient circulation of air, the burning of it becomes a matter of extreme difficulty and utterly unproductive of any useful result.

The economy claimed for the process as conducted at Halifax is described as being due to the employment of the Livet steam generator, which is shown in end elevation in the accompanying illustration, and may be thus briefly described. The two heaters are represented by A A, the upper cylinder by B and the conical circulating tubes uniting the upper cylinder to the heaters by C C. A separation, or rather division, is effected by the central wall, D, and the numbers 1, 2, 3 and 4 indicate the different flues in the order in which the gases pass through them after leaving the furnaces and flue tubes of the heaters, E E, on their way to the uptake. It will be seen, on reference to the illustration, that the third and fourth flues of each furnace are separated by fire-tile partitions, supported by the joists, F F. In the upper cylinder, B, the water and steam spaces respectively are shown by the letters H and G. The two upper cylinders of the feed-water heater are I I, while J is the lower cylinder, showing in each the 3 in. internal tubes.

Cast iron stools, K K, carry the two heaters, and L is the interlocking plate which completes the dividing partition between the two third flues of the two furnaces already described. The special feature of this furnace is that the form of the flues is such as will utilize the increasing weight of the products of combustion or gases as they travel toward the chimney, promote a high velocity of the air passing through the furnace bars, produce rapid combustion with intense heat, and cause the gases themselves to pass sufficiently slowly through the flues, so that they part with all their useful heat before they escape into the atmosphere. It is obvious that, in effecting this desirable result, it would not answer to strain or wiredraw the gases too much, or the consequence would be a defeat of the main object. It should be mentioned that the town refuse is delivered at Halifax free of charge at the furnace mouth in a raw state, and shovel-fed into the fire without any preliminary drying, shifting or screening, a very important point in the whole process. There was an entire absence of any unpleasant odor on the premises or in the interior of the furnace or generator house, which may possibly be due to the fact that the constant high temperature maintained, together with the great force of draught, secures complete combustion.

It is stated that the average quantity of rubbish burned per hour per square foot of grate surface of the Livet generator was 33 lb., while the furnaces at Oldham consumed only 25 lb. Both of these results are superior to the average obtained at Glasgow, which was nearly 21 lb.; but it is alleged that a maximum of 39 lb. has been obtained at the last-mentioned town per same units of time and grate surface. If we compare the quantity of water evaporated by the combustion of one pound of town refuse, we find that, while three-quarters of a pound is allotted to Oldham, it is claimed for the Livet generator that in its best performance it has evaporated over four pounds with rubbish containing 20 per cent. of moisture.

The statement for four different towns respecting pounds of water evaporated per pound of rubbish consumed is as follows: Halifax, 4·08; Bradford, 3·65; Harrogate, 3·39; Huddersfield, 3·59. In order to get rid of the objectionable light dust, the progression of the gases is partially arrested at the end of each flue, which enables them to deposit it in suitable expansion chambers or pits, which can be cleaned out as required, so that, after some months' use, the flues themselves have been found in a perfectly free and unclogged condition.

In a small compartment boarded off from the furnace room, but under the same roof of the temporary building of timber and corrugated iron, is simply placed upon balks, without any bolting down, a Parsons' combined steam turbine and dynamo of a somewhat old pattern, which serves to light three arc lamps of 2,000 candle power each, a search light fixed outside on the top of the building of 25,000 candle power and a small incandescent lamp swung over the dynamo. The capacity of installation at Halifax is equal to 100 effective electrical units, or 10,000 incandescent lamps of 10 candle power, each burning six hours a day, by the combustion of 3,000 tons, or one-third of the refuse of the town per annum, which, if the capacity were equal to burning all the rubbish produced, would give one lamp three and a half hours to each inhabitant.

## THE MANUFACTURE AND INDUSTRIAL VALUE OF ALUMINUM ALLOYS.*

By J. H. J. Dagger, F.I.C., F.C.S.

In the two papers I have had the honor of reading before this society, and in a paper read before the British Association in 1889, I gave some account of the present day methods for the production of this industrially new metal, and, expressing my views as to its value, based upon an especial experience of the metal in the laboratory, foundry, and workshop, I then stated that "the greatest value of aluminum is as yet in its alloys;" that these words hold true, and that the alloys of aluminum have a value that can hardly be overestimated, I will endeavor to set forth this evening. Aluminum alloys readily with all the common metals, with one or two exceptions, and with gold, silver, and platinum. These alloys may be conveniently considered as divided into two classes, simple and complex; aluminum alloyed with one metal or with two or more.

*The Simple Alloys.*—The most important are the copper alloys; these form two series: Aluminum bronzes with 1 to 11 per cent. of aluminum and aluminum copper alloys with 90–99 per cent. of aluminum. The intermediate alloys form a series differing widely in color and other physical characteristics of great scientific interest, but, owing to their crystalline, brittle nature, valueless in the arts. The 10 per cent. aluminum bronze is perhaps the best known; it was first prepared by Dr. Percy, of the Royal School of Mines, in 1855, and as early as 1859 a series of experiments

*Read before the Society of Chemical Industry, Dec. 6, 1893.—From the *Journal.*

Table I.

Aluminium Bronze.—Average Tests

| Aluminium Per Cent. | T.S. in Lbs. per Square Inch. | Elongation Per Cent. |
|---|---|---|
| 10 | 69—90,000 | 4—14 |
| 8½ | 55—65,000 | 12—28 |
| 7½ | 35—45,000 | 8—32 |
| 5—5½ | 35—40,000 | 30—40 |
| 2 | 30,000 | 40—50 |
| 1 | 20,000 | 40—65 |
| 11 | 90—100,000 | 0—8·0 |

were made with it, a mountain gun being cast of it under the direction of the Committee of Artillery of France, and in 1860 further experiments in this direction were made by the Bavarian military authorities, both the French and Bavarian experts reporting that the cost of aluminum bronze was the only thing then prohibiting its use for guns.

In his report on the Augsburg artillery trials, Colonel Weber states that the aluminum bronze resisted a pressure of 97,012 lb. per square inch, while the tin bronze then used gave only a pressure resistance of 39,601 lb. At that time pure aluminum was 38s., aluminum 10 per cent. bronze 4s. 11d., and tin bronze 1s. 3d. per lb.

Aluminum bronze is prepared by two methods. 1. By direct reduction of aluminum ore, such as corundum or rich bauxite in presence of metallic copper in the electric furnace; this method I have previously described.* Since that time, however, the old longitudinal furnace has been replaced by an upright one; the carbon walls now form the negative electrode, the positive being a bundle of carbon rods, plates, or a single carbon cylinder. The positive electrode is coupled to the cable as before, and is capable of being raised or lowered through an opening in the furnace cover; this cover is of iron and is kept cool by the circulation of cold water within it. At the bottom of the furnace is a tap hole closed by a carbon rod. By this method a rich alloy containing 20 to 30 per cent. of aluminum is obtained, which is checked by analysis and standardized by the addition of copper. The following is a typical analysis of this crude bronze or "furnace product:"

| | |
|---|---|
| Copper | 71·517 (by difference). |
| Aluminum | 20·147 |
| Silicon | 4·116 |
| Iron | 4·220 |

By using prepared alumina almost free from silica and iron, a very pure alloy can be obtained.

2. The better and more general method is by direct mixture of the metals in the crucible. The process is as follows: The copper is first melted, and then the necessary quantity of aluminum added in portions, using a perforated ladle to facilitate mixture. For the first addition of aluminum there will be great evolution of heat, rising to incandescence; this gradually diminishes as the remainder of the aluminum is added, care being taken to prevent overheating of the ladle and tools used during the mixing. The tools and ladle must be perfectly clean, free from scale, and it is best to change the hot rod for a fresh one. Black lead pots must be used, and the greatest care taken to prevent the molten metal coming into contact with sand or siliceous matter, for aluminum readily reduces silicon from its compounds. Fluxes must not be used, but carbon may be placed over the molten metal if thought needful. Much trouble and failure to obtain good results in the foundry has arisen from using clay pots, neglecting these precautions, and using too high a mixing temperature. If a bronze requires to be as free as possible from silicon, crucibles lined with carbon must be used. This bronze is of a bright golden color, its density is 7·69, it gives fine castings, is malleable, but requires frequent annealing if worked in the cold. It works well under the tool and takes a high polish.

The alloy containing 11 per cent. of aluminum is higher in tensile, transverse, and torsional strength; a small round cast bar tested by the Leeds Forge Company, Limited, gave T. S. 57·27 tons, or 128,000 lb. per square inch.

This alloy is exceedingly hard and trying to the tools, and in it we have reached the highest useful limit of aluminum in low per cent. alloys. The alloys containing less than 10 per cent. aluminum are all of very great value. The tensile, transverse, and torsional strengths and resistance to compression decrease as the aluminum is lowered; this is accompanied by a proportional increase of elongation. Their color varies from pale yellow to red gold; they can be readily cast, rolled, and drawn in the cold, and can be worked easily at bright red heat. Sheets, rods, bars, and wire are rolled at a bright heat and finished cold. The effect of working and rolling is shown in some of the tests given below. The fracture of the 10 and 11 per cent. bronzes are crystalline, that of the others fibrous.

You will notice that they far surpass ordinary bronze and gun metals, and compare favorably even with steel.

The destructive effect of heat on gun metal (tin bronze) is one of the most serious objections to the use of that alloy. The aluminum bronzes, on the contrary, show no sign of liquation on melting, and there is no separation of the metals on slow cooling, and so sounder castings can be made from them. They retain their tenacity through a high range of temperature. Professor Unwin obtained the following result with a bar of this bronze:

| Specimen. | Heated to ° F. | T.S. in Lbs. per Sq. Inch. | Per Cent of Elongation |
|---|---|---|---|
| 10 per cent. aluminium | 350° | 86,240 | 26·3 |
| Bronze, rolled bar..... | 500° | 84,828 | 27·5 |

* This *Journal*, September, 1889.

Other temperature tests made at Cowles Company's laboratory are given in my paper in the *Journal* for 1889.

*Complex Alloys of Aluminum.*—Of these the most important contain zinc and copper with varying proportions of aluminum, forming the so-called aluminum brasses. The composition of these alloys varies from 1 to 6 per cent. of aluminum, combined with 12 to 43 per cent. of zinc, the remaining constituent being copper.

The following tables indicate the composition and mechanical properties of this class of alloy.

The percentage of aluminum in aluminum brass depends upon the amount of zinc present, since the aluminum must decrease in quantity with an increase of zinc, otherwise the alloy will become brittle and unworkable. With 40 per cent. of zinc the aluminum should not exceed 1 per cent., with 30 per cent. of zinc 2 per cent. of aluminum, with 11 per cent. of zinc 6 per cent. of aluminum may be added. This alloy is best made by melting 10 per cent. aluminum bronze with the quantity of copper required, and when the ingots are melted and thoroughly mixed in the crucible, add-

Aluminium Brass.

| Notes. | Composition of Alloy. Cu. | Al. | Si. | Zn. | T.S. per Square Inch. Lbs. | Tons. | Elongation per Cent. | Authority. |
|---|---|---|---|---|---|---|---|---|
| Chill | 63·0 | 3·5 | 0·33 | 33·3 | 82,200 | 36·7 | 2·33 | United States Naval Department. |
| Castings | 63·0 | 3·3 | 0·33 | 33·3 | 70,400 | 31·4 | 0·40 | |
| Sand castings | 63·0 | 3·5 | .. | .. | 67,200 to 76,160 | 30 to 34 | 6 to 11 | Average tests at Milton Works laboratory. |
| Rolled bar | 63·0 | 3·5 | .. | .. | 84,672 | 37·8 | 9·7 | |
| Duplicate of above, rolled hot from 3 square inch pillar to 1¼ inch, then when cold to 1 inch square pillar. | 63·0 | 3·5 | .. | .. | 87,360 | 39·0 | 12·5 | |
| | 57·0 | 1·0 | .. | 42·0 | 52,800 | 23·5 | .. | Pittsburg Aluminium Company, U.S.A. |
| | 70·0 | 2·0 | .. | 28·0 | 68,600 | 30·6 | .. | |
| | 67·4 | 5·8 | .. | 26·8 | 96,900 | 43·2 | .. | |
| Cast bars cut from propeller blade castings:— 6″ × 1″ | .. | .. | .. | .. | 76,187 | 34·0 | 1·5 | Tested at Lloyd's proving house, Netherton, for Cowles Company, Limited. |
| 12″ × 2″ | .. | .. | .. | .. | 72,912 | 32·5 | 1·0 | |
| 18″ × 3″ | .. | .. | .. | .. | 66,752 | 29·7 | Slight | |
| | 66·0 | 1·0 | .. | 33·0 | 58,240 | 26·0 | 50·0 | Neuhausen Company's laboratory tests. |
| | 65·0 | 2·0 | .. | 33·0 | 69,440 | 31·0 | 30·0 | |
| | 64·0 | 3·0 | .. | 33·0 | 89,480 | 39·5 | 7·0 | |

Table II.

Comparison of Aluminium Bronze with Gun Bronze, Iron, and Steel.

| Metal or Alloy.—Description. | Tensile Strength. | Elastic Limit. | Elongation. | Authority. |
|---|---|---|---|---|
| | Lb. per Sq. In. | Lb. per Sq. In. | Per Cent. | |
| Steel, average of 137 specimens of accepted gun steel, oil tempered and annealed, hoops, jackets, and tubes. | 96,150 | 51,611 | 19·93 | United States Government tests of ordnance metal. |
| Same grades of steel, 19 specimens not tempered or annealed. | 88,000 | 38,140 | 18·70 | |
| Cast gun steel, German soft | 70,784 | 35,392 | .. .. | Holley ("Ordnance and Armour"). |
| Wrought iron forgings:— Small bars { Highest | 73,000 | 30,000 | .. .. | .. .. .. |
| Small bars { Mean | 53,000 | 18,000 | 26·0 | .. .. .. |
| Heavy forgings, average of 700 tests | 48,160 | 23,760 | .. . | Sir W. G. Armstrong's Works tests. |
| Cast iron, average of four specimens of accepted iron | 30,000 | 17,000 | 0·166 | Watertown Arsenal United States Government tests. |
| Gun bronze, average of 14 tests:— Copper 88·0, tin 10·0, zinc 2·0 | 38,995 | 13,214 | 33·6 | Watertown Arsenal tests. |
| „ 92·0 „ 8·0 | 29,008 | .. .. | .. .. | Anderson. |
| „ 91·7 „ 8·3 | 31,001 | .. .. | .. .. | „ |
| „ 91·0 „ 9·0 | 32,995 | .. .. | .. .. | „ |
| „ 90·0 „ 10·0 | 37,990 | . . | .. .. | „ |
| „ 92·0 „ 8·0 | 43,200 | 5,672 | 40·0 | General Uchatius. |
| „ 88·0 „ 10·0, zinc 2·0 | 18,000 | 10,000 | 2·5 | United States Navy Department tests. |
| „ 82·0 „ 10·0 „ 2·0 | 24,590 | 11,000 | 8·2 | |
| „ 82·0 „ 10·0 „ 2·0 | 23,750 | 13,000 | 3·7 | |
| Gun steel, average results of tests of Firminy, St. Etienne steel for French artillery. | 98,134 | 57,796 | 16·0 | Tests at gun factory of the Forges et Chantiers de la Mediterranée. |
| Aluminium bronze:— Al 10·0, Si 1·0, Cu 89·0 | 114,514 | .. .. | 0·45 | United States ordnance tests. |
| „ „ „ | 109,823 | 79,894 | 0·05 | |
| „ „ „ | 105,000 | .. .. | 6·0 | .. „ .. |
| Aluminium bronze, Al 10, Si 1, Cu 89, rolled hot from 2 inch billet to ¼ inch round bar. | 111,400 | Report reads probable elastic limit 84,000 | 6·5 | United States Government Watertown Arsenal test. |
| Aluminium bronze, Al 10, Si 1, Cu 89 | 128,400 | .. | Nil. | Leeds Forge Company's test |
| „ „ „ | 99,680 | .. | 5·7 | C.S. Company's Works, Milton. |
| „ „ 10 per cent. Al | 89,743 | 39,737 | 33·26 | Professor Umoin. |
| „ „ cast in sand | 87,510 | .. | 17·0 | Watertown Arsenal test. |
| Aluminium bronze, 7½ per cent. Al, Si 0·75 per cent., Cu 91·75 per cent. | 69,800 | 21,500 | 32·8 | „ „ |
| Cast in cbill mould | 68,000 | 24,000 | 18·2 | |
| Aluminium bronze, Al 7·5 per cent., Si 0·75, Cu 91·75 | 60—65,000 | .. | 20·0 | Otis Iron Works test. |
| Same after rolling into rod | 83,000 | .. | 39·0 | Otis Iron and Steel Works, Cleveland, Ohio, U.S. |
| Aluminium bronze, Al 7·75 per cent., Si 0·75 per cent., Cu 91·5 per cent. | 60,700 | 18,000 | 23·20 | United States Government, Navy Department tests. |
| Aluminium bronze, Al 7·75 per cent., Si 0·75 per cent., Cu 91·5. | 67,600 | 24,000 | 13·0 | |
| Aluminium bronze, Al 7·5 per cent., Si 0·5 per cent., Cu 92·0. | 46,550 | 17,000 | 7·8 | |
| Aluminium bronze bar, Al 5 per cent., rolled | 82,880 | .. | 60·0 | Tested at Phœnix Works, Ruhort, Germany. |
| „ „ 10 per cent | 91,392 | .. | 1·5 | Tests made at South Boston Ironworks by Mr. E. D. Self, on six-inch long bars. |
| „ „ 10 „ | 92,512 | 59,808 | 2·5 | |
| „ „ 10 „ | 96,320 | 85,120 | 1·0 | |
| „ „ 9 „ | 77,056 | 51,744 | 9·0 | |
| „ „ 9 „ | 71,680 | 43,904 | 9·0 | |
| „ „ 9 „ | 71,680 | .. | 8·5 | Watertown Arsenal. |
| „ „ 8 „ | 57,792 | .. | 12·5 | „ „ |
| „ „ 8½ „ | 71,904 | .. | 28·5 | E. D. Self, at South Boston Ironworks. |
| „ „ 7½ „ | 60,700 | 45,472 | 6·0 | |

ing the zinc. The metal is left in the furnace until small test bars taken from it and broken show the required tensile strength and ductility; it is then ready for pouring.

Other alloys of this class contain small percentages of manganese and tin, usually not exceeding 0·5 of either metal.

The following is an example of this alloy :—

| Specimen. | Composition. | | Tensile Strength. | Elongation. |
|---|---|---|---|---|
| Cast bar of aluminium-manganese bronze. | Aluminium .. | 2·000 | 85,300 lb. per sq. in. | 24·25 per cent. |
| | Zinc..... | 34·000 | | |
| | Manganese... | 0·300 | | |
| | Tin..... | 0·500 | | |
| | Copper ..... | 63·200 | | |
| | | 100·000 | | |

Metal for rolling into sheets and rods has often 0·5 per cent. of lead added to the alloy. Aluminum brass can be forged and worked readily under the hammer; the working heat must be lowered with the decrease in the percentage of aluminum. The 3 per cent. aluminum alloy with 33 per cent. of zinc can be worked at a dark red heat, contrasting in this respect with common brass. These alloys all give sharp, clean, tough castings, and from their high tensile and transverse strength and their corrosion resistance they ought to be most valuable to the marine and mechanical engineer. They have already been tried as a material for propeller blades, and, judging from results obtained, ought to displace other bronzes in this class of work.

*The Casting of Aluminum Bronze and Brass.*—The following are the melting points of aluminum bronze, as compared with the pure metal and other alloys and metals:

| Metal or Alloy. | Melting Point. |
|---|---|
| | ° F. |
| Aluminium..... | 1,300 |
| Copper..... | 1,990 |
| Iron..... | Cast, above 2,780<br>Wrought, above 4,000 |
| Steel..... | 4,000 |
| Steel bronze (gun bronze)..... | 1,190—1,200 |
| Aluminium bronze (aluminium brass). | 1,600—1,700 |

In making castings from aluminum bronze and brass the difficulties, as in other metals and alloys, arise from oxidation, contraction, shrinkage, and the inclosing of air bubbles, but no gases are produced during the melting of the alloy, and there is no trouble from the occlusion of gases, as in the case of other metals.

The liquid bronze on exposure to air is instantly covered with a thin film of oxide, which protects the under metal from any further oxidation; in pouring, care must be taken to prevent any of this film getting into the casting; this is best done by making a "pouring gate" or receiver, into which the metal is first poured.

The molten bronze is kept back until the impurities have risen to the surface, when the plug is withdrawn and the clean metal enters the mould. Instead of a "pouring gate" a secondary pot or ladle can be used.

Contraction must be guarded against by having cores of a yielding character, avoiding as far as possible core rods or irons; coarse sand mixed with resin, which softens on heating, makes a good core. To diminish shrinkage the gates must be made as large as possible and the pouring done quickly, and at no higher temperature than is necessary to insure a good casting.

HIGH PER CENT. ALLOYS.

| Composition. Al. | Cu. | Specific Gravity. | T S. in Tons per Sq. Inch. | T.S. in Lbs. per Sq. Inch. |
|---|---|---|---|---|
| 98 | 2 | 2·71 | 19·6 | 43,904 |
| 96 | 4 | 2·77 | 19·90 | 44,576 |
| 94 | 6 | 2·82 | 24·70 | 55,328 |
| 92 | 8 | 2·86 | 22·70 | 50,848 |
| Aluminum | .. | 2·67 | 12·0 | 26,880 |
| Al, 97—98 | Titanium, 2—3 % Langley's patent. | .. | 17·8 to 26·7 | 40,000 to 60,000 |

*High Per Cent. Aluminum Alloys.*—Very many experiments have been made to increase the tensile strength and hardness of aluminum, and with considerable success, though at some slight sacrifice of lightness and corrosion resistance. For ordinary foundry and workshop castings the addition of 1–6 per cent. of copper is the most ready and serviceable method. The mechanical tests of such an alloy are shown in the table. The addition of only 2 per cent. of copper increases the tensile strength of rolled aluminum from 12 to 19½ tons per square inch, while 6 per cent. doubles it; a further addition of copper increases both the hardness and brittleness, but the alloys containing between 12 and 90 per cent. of aluminum are industrially valueless.

*The Alloys with Tin.*—From my own experiments I find the addition of not more than 2½ per cent. of tin to aluminum gives a hard serviceable alloy with a slightly improved color. Richer alloys are crystalline and brittle. (Samples containing 2 per cent. and 50 per cent. of tin were exhibited.)

COMPARATIVE TESTS OF TRANSVERSE STRENGTH.

| Material. | Cross Section of Bar in Inches. | Length of Bar between Supports. | Breaking Load | Limit of Elasticity | Permanent Deflection | Resilience. At Elastic Limit. | Resilience. At Ultimate Strength. | Percentage Composition. |
|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | Cwt. | Cwt. | Inches. | | | |
| Cast iron..... | 1 | 12 | 16 to 20 | .. | .. | .. | .. | .. |
| Gun metal..... | 1 | 12 | 26 | 18 | 3⅜ | 0·07 | 0·13 | .. |
| Manganese bronze ..... | 1 | 12 | 54 | 38 | 3 3/16 | 0·15 | 0·23 | .. |
| Aluminium-Hercules bronze .. | 1 | 12 | 56 | 50 | 3¼ | 0·18 | 0·24 | Al ¾—1 per cent. Zn 40—42. |
| Aluminium-manganese bronze. | 1 | 12 | 61 | 56 | 1·8 | 0·22 | 0·25 | Al 2¾, Mn ⅛, Zn 34½, Sn ⅛. |
| Aluminium brass..... | 1 | 12 | 72 | 64 | ⅝ | 0·2 | 0·23 | Al 3⅓, Zn 33⅓ |

CORROSION RESISTANCE OF ALUMINIUM ALLOYS. NEUHAUSEN LABORATORY TESTS.

| Specimen. | Weight in Grms. | Surface. | Reagent. | Temperature. | Time of Exposure. | Loss Per Cent. |
|---|---|---|---|---|---|---|
| 2·4 per cent. aluminium bronze..... | 9·346 | 50 cm. sq. | 5 per cent. acetic acid. | Ordinary. | 504 hours. | 0·440 |
| 10 per cent., free from silicon ..... | .. | Equal surfaces. | 4 per cent. acetic acid and 3 per cent. solution of common salt. | 80°—90° C. | 14 „ | 1·0 |
| 10 per cent. aluminium bronze with 2·8 per cent. of silicon.* | | | | | | 2·1 |
| Aluminium brass, 3·5 per cent. aluminium. | | | | | | 4·4 |
| | 17·452 | 22 cm. sq. | Pure conc. $H_2SO_4$ | 6°—11° C. | 336 hours. | 0·401 |

* A specimen tested in the Milton Laboratory indicates the influence of silicon on corrosion resistance. A polished bar of 10 per cent. bronze, normal colour, strength, and elongation, gave following result :—

The action of the sulphuric acid developed a dark band in form of a spiral round the bar; this showed minute corrosion pits under lens, which gave off sulphuretted hydrogen; the corrosion was apparently confined altogether to this dark patch. Silicon alloyed with iron is often left as a black insoluble powder on dissolving the bronze in aqua regia.

COMPARATIVE TRANSVERSE TESTS, ON BARS 1 IN. × 1 IN. × 12 IN.

| Gun Metal. Stress Applied. | Deflection under Stress. | Permanent Set. | Resilience. |
|---|---|---|---|
| Cwts. 8 | 0·03 | | |
| 10 | 0·045 | | |
| 12 | 0·06 | 0·015 | 0·045 |
| 14 | 0·09 | 0·04 | 0·05 |
| 15 | .. | .. | .. |
| 16 | 0·15 | 0·09 | 0·06 |
| 18 | 0·27 | 0·20 | 0·07 |
| 20 | 0·46 | 0·38 | 0·08 |
| 22 | 0·75 | 0·65 | 0·10 |
| 24 | 1·08 | 0·97 | 0·11 |
| 25 | .. | .. | .. |
| 26 | 1·59 | 1·46 | 0·13 |
| Shipped through supports. Permanent deflection, 3⅝ in | | | |

| Manganese Bronze. Stress Applied. | Deflection under Stress. | Permanent Set. | Resilience. |
|---|---|---|---|
| Cwts 8 | | | |
| 10 | | | |
| 12 | | | |
| 14 | 0·06 | | |
| 15 | .. | .. | .. |
| 16 | 0·07 | | |
| 18 | 0·08 | 0·005 | 0·075 |
| 20 | 0·09 | 0·01 | 0·08 |
| 22 | | | |
| 24 | | | |
| 25 | .. | .. | .. |
| 26 | | | |
| 28 | | | |
| 30 | 0·20 | 0·075 | 0·125 |
| 32 | 0·23 | 0·105 | 0·125 |
| 34 | 0·28 | 0·140 | 0·140 |
| 35 | .. | .. | .. |
| 36 | 0·34 | 0·19 | 0·15 |
| 38 | 0·41 | 0·26 | 0·15 |
| 40 | 0·49 | 0·33 | 0·16 |
| 42 | 0·59 | 0·425 | 0·165 |
| 44 | 0·70 | 0·53 | 0·17 |
| 45 | .. | .. | .. |
| 46 | 0·81 | 0·63 | 0·18 |
| 48 | 1·16 | 0·96 | 0·20 |
| 50 | 1·39 | 1·17 | 0·22 |
| 52 | 1·70 | 1·47 | 0·23 |
| 54 | Fractured. | | |
| Permanent deflection, 3 3/16 in. | | | |

| Aluminium Brass. Stress Applied. | Deflection under Stress. | Permanent Set. | Resilience. |
|---|---|---|---|
| Cwts. 8 | | | |
| 10 | 0·02 | 0 | |
| 12 | | | |
| 14 | | | |
| 15 | 0·04 | 0 | |
| 16 | | | |
| 18 | | | |
| 20 | 0·06 | 0 | |
| 22 | | | |
| 24 | | | |
| 25 | 0·08 | 0 | |
| 26 | | | |
| 28 | | | |
| 30 | 0·10 | 0 | |
| 32 | | | |
| 34 | | | |
| 35 | 0·12 | 0·01 | 0·11 |
| 36 | | | |
| 38 | | | |
| 40 | 0·15 | 0·02 | 0·13 |
| 42 | | | |
| 44 | | | |
| 45 | 0·18 | 0·03 | 0·15 |
| 46 | 0·19 | 0·03 | 0·16 |
| 48 | 0·20 | 0·04 | 0·16 |
| 50 | 0·21 | 0·05 | 0·16 |
| 52 | 0·23 | 0·06 | 0·17 |
| 54 | 0·24 | 0·08 | 0·16 |
| 56 | 0·28 | 0·10 | 0·18 |
| 58 | 0·31 | 0·12 | 0·19 |
| 60 | 0·35 | 0·16 | 0·19 |
| 62 | 0·40 | 0·20 | 0·20 |
| 64 | 0·46 | 0·26 | 0·20 |
| 66 | 0·54 | 0·32 | 0·22 |
| 68 | 0·63 | 0·40 | 0·23 |
| 69 | 0·67 | 0·45 | 0·22 |
| 70 | 0·7 | 0·50 | 0·23 |
| 71 | 0·79 | 0·56 | 0·23 |
| 72 | Break. | | |
| Permanent deflection, ⅝ in. | | | |

*The Alloys with Titanium.*—For information as to these alloys I am indebted to Dr. J. W. Richards, Professor of Metallurgy at Lehigh University, U. S. A.

The alloy containing 2 to 3 per cent. (Langley's patent) gives a tensile strength of 40,000 to 60,000 lb. per square inch in forgings; this alloy is especially useful for horse shoes, stirrups, bits and small strong fittings.

*Alloys with Nickel and Zinc.*—The addition of nickel lowers the melting point, and increases the hardness and elasticity, if added in quantities not exceeding 2 per cent. Above this figure the alloy is brittle and useless.

With zinc, aluminum forms hard, close-grained, brittle alloys having a lower melting point than that of the constituent metals. A small ingot containing 10 per cent. of aluminum and 90 per cent. of zinc is among the samples on the table. A very useful alloy contains 3 per cent. of German silver. It has double the tensile strength of aluminum itself. Professor Richards had samples of it tested at Watertown Arsenal, and while not quite equal to the titanium alloy in tensile strength its elasticity was greater; this alloy is suitable for knives, spatulas, paper cutters, spectacle frames, and all uses where elasticity is essential.

*Alloys with Silver.*—Aluminum alloys readily with silver in all proportions. With up to 6 per cent. of silver the elasticity and hardness increase, beyond this proportion the brittleness increases, but alloys containing up to 30 per cent. of silver are serviceable. These alloys, owing to their hardness, lightness, bright luster and permanency, are excellent for art work.

*Chromium Alloys.*—For a description of these alloys I have to thank Mr. H. N. Yates. He finds from experiment that the addition of chromium increases the

hardness, while it reduces the strength and ductility of the aluminum.

*Cadmium Alloys.*—Aluminum is said to form malleable fusible alloys with cadmium in all proportions, but I have not been able to verify this statement.

*Alloys with Iron, etc.*—Aluminum alloys readily with iron in all proportions. Aluminum containing more than 1 to 2 per cent. of iron is hard and brittle; with 8 per cent. the alloy crystallizes in needles.

Iron containing 15 to 16 per cent. of aluminum cast in the chill is marked by the file with difficulty; the fracture is fine and crystalline.

An alloy of steel containing 1 per cent. of manganese with 7 per cent. of aluminum will just scratch glass. Although aluminum is said by some writers to diminish hardness in iron, used in even small proportions, it is to my mind sufficiently clear that this depends entirely upon the change in the state of the contained carbon.

Above 5 per cent. of aluminum rapidly destroys the magnetic properties of iron, and some time ago experiments were carried out in the Milton laboratory to determine whether this phenomenon would furnish any clew to the percentage of aluminum present in iron alloys, but the results were not precise enough for quantitative indications.

*The Use of Aluminum in Melting and Casting other Metals.*—Very large quantities of the aluminum produced go for use in iron and steel founding in this country, and Professor Richards and Mr. Yates report that there is hardly a steel melter in the States that tries to do without it, and that they are the largest users. This brings me to the consideration of the influence of minute quantities of aluminum on other metals. The percentage used is so small that such mixtures cannot be truly termed alloys. The action of aluminum is probably twofold, chemical and physical. Chemical, owing to its affinity for oxygen and the stable character of the oxide when formed; physical, causing changes in the structure of the alloy, crystalline to non-crystalline.

The effect of aluminum is due to—

First. Its action on the combined carbon, changing it to the graphitoidal form; the carbon is apparently liberated at the moment of solidifying and uniformly. 0·25 per cent. of aluminum added to white iron renders it perceptibly darker in color, 0·5 per cent. darker still, and 0·75 per cent. renders it gray, with no sign of white. Up to 4 per cent. the effect is similar; the castings are softer and grayer as the aluminum increases.

Secondly. Its action on the dissolved oxides of iron and silicon. These are reduced, with the formation of alumina, iron, and free silicon.

Thirdly. Decomposition of gaseous and solid compounds of carbon with oxygen and hydrogen entangled in the molten metal. This is why aluminum is so valuable in steel casting. Some experiments carried out by Professor Langley, of Pittsburg, explain this action clearly. Blow holes in steel are due to non-oxidizing occluded gases, hydrogen, carbonic oxide, and nitrogen separating, under a pressure of many atmospheres, from steel just before solidification. It has been proved by repeated experiment that aluminum readily decomposes carbonic oxide below steel melting heat, forming alumina and free carbon. Professor Langley confirmed this by blowing 40 gallons of pure carbonic oxide through a crucible of molten steel containing aluminum, and obtained an increase of 35 per cent. on the carbon present before passing the gas. The quantities of aluminum used vary with the quality of the steel. For open hearth metal with less than 0·5 per cent. of carbon, 5 to 10 oz. per ton. For steel over 0·5 per cent. of carbon, aluminum must be used cautiously, the quantity usually being 4 to 8 oz. per ton.

These quantities, you will notice, are very minute; 4 oz. per ton being 0·0125 per cent., 16 oz. would be 0·05 per cent. Professor Richards and Mr. A. E. Hunt have patented an alloy made by adding 10 to 20 per cent. of aluminum to ferro-manganese. The addition of the aluminum causes a separation of carbon, and an alloy with less carbon than ordinary ferro-manganese is obtained, admitting of melting softer steel with down to 0·05 per cent. of carbon. As might be expected from its influence on iron and steel, aluminum is useful in the preparation of other metals. It is much used by American galvanizers and brass founders for adding to molten zinc; its action is to reduce the oxide disseminated through the bath. Its effect on the galvanized sheets is at once perceptible. The amount used is 0·005 to 0·010 per cent. of aluminum, usually in the form of the 4 per cent. aluminum alloy of zinc; one firm in the United States puts 2,000 tons of aluminum zinc on the market yearly. The process is patented in this country. A small quantity added to copper, 0·05 to 0·5 per cent. decomposes entangled oxides and enables sounder and more ductile castings and ingots to be produced without hardening the metal or affecting its electrical conductivity.

In conclusion I would say that the true value of aluminum is not yet known as it ought to be to those engaged in the metallurgical industries of this country, and in its use and applications we are behind the Continent and the United States. In the arsenals, shipbuilding yards, machine shops, and factories of France, Germany, Switzerland, Italy, Denmark, Russia, and the United States, aluminum and its alloys are taking the place of the older tin, zinc, and copper alloys, of cast iron, and in some cases that of steel itself.

I have to express my thanks to Professor Richards and Mr. H. N. Yates for communication of facts as to experiments and use of the metal in the United States; to the Cowles Syndicate Co. for specimens of alloys; to Messrs. Blackwell for specimens of bauxite; to Mr. Lloyd Barnes, of the Liverpool School of Science, for a test of the electrical conductivity of aluminum; to Dr. Bailey for assistance in preparation of the diagrams; and to Mr. C. Boundy for the use of his metallurgical laboratory.

## THIOCARBAMID.

Such is the name of a new preparation for clearing and removing stains from negatives. It is very often noticed that the gelatine layers of negatives and positives assume discolorations through the use of certain developers, or when old fixing solutions are used. This discoloration makes such negatives or positives undesirable. For bromide enlargements, for instance, which are still, to a great extent, developed with ferrous oxalate, it is necessary to use a special clearing bath to prevent the yellow staining which would invariably take place. To remove these and other stains, this new preparation in acid solution is specially suitable, and has the advantage (while leaving the image absolutely untouched) of bringing about a permanent removal of stains or discolorations, which cannot be said of other mediums. Its application is as follows: The negative or paper print (bromide or chloride silver plates and papers) are previously fixed with hypo, and after the hypo has been thoroughly removed by washing, the negative or paper print is put into the following solution until the discoloration or stain has disappeared:

| | |
|---|---|
| Thiocarbamid | 300 grains |
| Citric acid | 150 grains |
| Water | 1 quart |

Another solution may be prepared by mixing:

| | |
|---|---|
| Thiocarbamid | 300 grains |
| Alum | 300 grains |
| Acetic acid | 150 grains |
| Water | 1 quart |

The formula of this preparation is as follows:

$$CS\begin{matrix}NH_2\\NH_2\end{matrix}$$

The solution can also be used for fixing silver chloride negatives and positives. It should be noted that an alkaline solution is inadmissible.

[Continued from Supplement, No. 952, page 15220.]

## CHEMICAL PROPERTIES OF GASES.*

By Francis C. Phillips.

### (III) ORIGIN OF NATURAL GAS AND PETROLEUM.

Soon after the early discoveries of oil and gas in Pennsylvania, the geologists proposed a hypothesis to account for the origin of these remarkable substances.

Remains of the marine vegetation of the Devonian inland sea, as they were gradually buried under the later accumulations of sediment and exposed to gentle heat from below, underwent a slow process of destructive distillation. In this way, all the varieties of petroleum and natural gas were produced. This view, adopted from a purely geological standpoint, seemed so plausible that for a long period no other was thought of. Mr. J. F. Carll, of the Second Geological Survey of Pennsylvania, has discussed the hypothesis very exhaustively in his various official reports. If this view is correct, oil and gas are probably stored products, and are not being continuously generated at the present time.

Opposed to this view is the more strictly chemical hypothesis of Mendeleeff, who, in 1876, expressed his belief that petroleum and gas are of igneous origin.

On account of the high value assigned by astronomers for the mean density of the earth as compared with that of the surface rocks, it follows that the heavy metals are mainly accumulated at great depths where a temperature of fusion may be assumed. Many of these metals combine readily with carbon to form carbides. Iron in form of a carbide, when exposed to steam at high temperatures, is rapidly oxidized, the hydrogen of the water then combining with the carbon set free and producing hydrocarbons.

Citing experiments of Cloez, who produced mixtures of hydrocarbon oils by the action of hydrochloric acid upon ferromanganese, Mendeleeff concluded that such reactions have occurred at great depths below the earth's surface by the contact of steam with incandescent metallic carbides.

"During the upheaval of mountain ranges, crevices would be formed at the peaks with openings upward, and at the foot of the mountains with openings downward. Thus there was opportunity for the water to penetrate to great depths and for the hydrocarbons to escape. The situation of naphtha at the foot of mountain chains is the chief argument in my hypothesis." (Mendeleeff, "Principles of Chemistry," vol. i., p. 365.)

According to this view, oil and gas are being continuously generated, for there is no reason to suppose that the masses of metallic carbides in the earth's interior are exhausted; such, in fact, seems to be Mendeleeff's view.

Mendeleeff points especially to the absence of large quantities of nitrogen compounds in petroleum as an argument in favor of the hypothesis.

The objection has been urged against this hypothesis that petroleum, if thus produced, should be abundant in the primary rocks, from which it is usually absent. The originally heated condition of these rocks would have prevented the condensation of oil, however, and, although the vapors may have passed through the earlier rocks, there is no reason to expect that condensation should have occurred before reaching much higher strata.

While on geological grounds difficult to prove or disprove, it meets with one fatal objection. The composition of natural gas in Pennsylvania does not justify the supposition that superheated steam and carbon have been concerned in its formation. We should certainly look, in such a case, to find natural gas composed mainly of free hydrogen containing small quantities of paraffins, olefines and carbon monoxide. When it is considered that paraffins alone cannot under any known circumstances be produced from the oxidation of carbide of iron by steam, the hypothesis does not seem to be tenable.

It is true that varying conditions of temperature might have produced a great variety of hydrocarbons, but no evidence has yet been obtained that paraffins alone result from such a reaction. In an experiment made with ferromanganese and dilute sulphuric acid, the gas evolved was found to contain 6 per cent. of olefines.† It is further to be noticed that this hypothesis requires that water should take part in the process, yielding up its hydrogen, while, according to the older geological hypothesis, the water may have served mainly to cover and give protection from atmospheric oxidation, if it has been concerned at all in the reaction.

Water contains dissolved oxygen, and in descending to the iron carbides, must have given off its dissolved oxygen long before reaching the region at which actual formation of hydrocarbons could occur. Hence, on this hypothesis, oxygen should be found in natural gas in larger quantity than the chemical tests indicate. In fact, in rocks of moderately high conducting power, a wide interval would exist between the depth at which the water boils and the much greater depth at which water vapor could oxidize metallic iron in quantity. It is doubtful whether water could have traversed this interval so as to reach the latter depth at all.

Engler (*Ber.*, vol. xxi., p. 1816, and vol. xxii., p. 592) has published the results of interesting investigations upon the distillation products of menhaden fish oil. By conducting the distillation at a high pressure (25 atmospheres), this author produced a mixture of hydrocarbon oils from which a large number of normal paraffins were obtained, compounds not found elsewhere in nature than in petroleum.

This has led to the revival of an older theory as to the origin of petroleum and gas, *i. e.*, that they have resulted from the distillation under pressure and at low temperatures of the accumulated remains of marine life buried under the sediments of the ancient Devonian seas.

Much has been written in support of the hypothesis of Engler, and it may be said to have gained very general acceptance in Europe.

Ochsenius (*Chem. Zeitung*, 1891, p. 936) has summarized many of the arguments usually adduced in support of the hypothesis.

This author says: "Concerning the origin of petroleum, there is now no doubt that, with a few exceptions, animal remains (mainly of marine life) have yielded the raw material."

Originally the opinion was held that it was derived from vegetable matters, because the accumulation of animal remains sufficient to account for its formation by any distillation process in the rocks could not be explained. Distillation of vegetable matters would, however, have left greater deposits of coal (as a residue in the Devonian rocks). But petroleum occurs in rocks of marine formation where coal is uncommon. Rocks in which plant remains are found do not contain bitumen (petroleum). If animal remains are associated with those of plants, then bitumen is usually found.

The objection urged against the hypothesis of Engler, that nitrogen does not occur in petroleum, is easily overcome by the fact that nitrogen of animal tissues tends finally to produce ammonia, and this in the case of petroleum may have been carried away in solution by water; hence, the absence of nitrogen compounds.

From Engler's experiments, it appears that animal fats are the chief source of petroleum.

It is true that fatty matters do not ordinarily sink in water, although Von Guembel, in the voyage of the Gazelle, found fat globules in dredgings from the bottom of the Atlantic Ocean, in water 15,000 feet deep.

Putrefactive changes would tend to yield considerable quantities of ammonia and carbon dioxide. These in presence of salt water would produce alkali bicarbonate and ammonium chloride. Hence, alkaline waters might be looked for in the neighborhood of petroleum. The petroleum at Pechelbronn is associated with water containing 0·5 per cent. of alkaline carbonate. (In Western Pennsylvania many cases are known of water having a decided alkaline reaction in the neighborhood of gas wells. In Murrysville gas territory, water of alkaline reaction was so abundant as to seriously interfere with gas development.—Note by F. C. P.) Such alkaline waters are not known in archæan rocks, and are not, therefore, likely to be derived from greater depths than the rocks in which they are found.

Probably no cases can be cited where fatty tissues alone of buried animals have yielded oil or gas. The presence of strongly saline water is apparently needed.

Great differences occur in the chemical character of petroleum. Caucasian oils are mainly composed of olefines or substances related to the olefine group. The German oils are mixtures of paraffins and olefines, while the American are chiefly paraffins. Such differences may be attributed to the character of the rock in which the distillation has occurred. Sandstones will probably prove without action; while limestones, by reason of their basic character, would tend to strongly influence the products.

Such are some of the arguments of Ochsenius in favor of Engler's hypothesis.

If this view is accepted, it follows that the generation of petroleum and gas must be considered as a finished process, so far as all existing productive gas and oil regions are concerned.

Engler has analyzed the gas evolved when (1) menhaden oil and (2) when oleic acid are distilled under atmospheric pressure and under a pressure of 25 atmospheres.

| | Menhaden Oil. | | Oleic Acid. | |
|---|---|---|---|---|
| | 1 atmos. | 25 atmos. | 1 atmos. | 25 atmos. |
| Methane | 25·2 | 38 3 | 9·3 | 4·36 |
| Olefines | 11·4 | 7·8 | 12·5 | 2·9 |
| Carbon dioxide | 26·7 | 17·4 | 37·2 | 26·0 |
| Carbon monoxide | 34·9 | 34·5 | 38·6 | 25·5 |
| Incombustible residue | 1·8 | 2·0 | 2·4 | 2·0 |

(*Ber.*, 1889, p. 592.)

The liquid distillates produced at the same time that these gases were evolved were rich in the normal paraffins and their isomers.

One hundred parts of menhaden oil yielded 8·9 parts of gas and 63 parts of liquid oils.

A strong argument in support of the Engler hypothesis is found in the fact that by distillation of fish oils, besides methane, several of the lower paraffins are produced in large quantity. Hydrocarbons of the paraffin series are not obtainable in such proportions by the distillation at high temperatures of other organic material under ordinary conditions.

It should be noted as a fact of much interest as regards the result of Engler's researches, that in the distillation at higher pressures the proportion of olefines contained in the gases evolved is considerably less. This is also true of carbon monoxide when oleic acid was distilled. It is to be regretted that Engler's experiments were not repeated at still higher pressures, in order to ascertain whether these same constituents

* Read before the American Philosophical Society, March 17, 1893.—*Light, Heat and Power.*

† Experiments by F. C. P.

of the evolved gases diminish progressively with increased pressure.

Engler was the first to show clearly that the problem of the origin of oil and gas must be studied from the chemical rather than the geological standpoint. The hypothesis advanced by this author has been very generally accepted.

Nevertheless, my examinations of natural gas have led me to doubt some of his conclusions, well founded as they seem. The most careful tests, carried on during a period of six years, have failed to show the presence of either olefines or carbon monoxide in the natural gas of Western Pennsylvania.

Some of the constituents of gas are soluble in water. This is notably the case with carbon dioxide, butane, hexane, etc. If ethylene and carbon monoxide have been produced even in much smaller proportion in the rocks than Engler finds in menhaden oil gas, these substances would now occur in the natural gas of Pennsylvania. Ethylene would give to the gas such illuminating power that there would be no occasion for the use of coal gas in any town in the Western Pennsylvania gas region. As a matter of fact, natural gas is almost useless as an illuminant, its light being equal to 5 to 11 candles per 5 feet of gas consumed per hour.

Mr. Robert McKinney, formerly gas inspector of Allegheny County, found as a mean of forty trials of natural gas supplied to Pittsburg an illuminating power of 6·5 candles.

Mr. J. W. Patterson, the present gas inspector of the county, states that the illuminating power of natural gas as supplied to Pittsburg in November, 1892, is a little less than 11 candles per 5 feet per hour. The reason for this is that natural gas, as found in Pennsylvania, does not contain olefines. If carbon monoxide occurred in gas, there would have been innumerable cases of poisoning among workmen at gas wells. It is common to find such leaks of gas about the majority of gas wells that no one could strike fire at a well without risk of fatal consequences. Although inhaling the escaping gas for much of a lifetime, a gas well driller will usually maintain that no bad effects to health come from exposure to the gas. Air containing 0·2 per cent. of CO is known to produce dangerous effects upon health.

According to Wyss (*Zeit. Ang. Chem.*, 1888, p. 465), air containing 0·1 per cent. of water gas is poisonous to breathe.

It is hardly probable, moreover, that CO or $C_2H_4$ occurring in gas could have been absorbed or removed at low temperatures by any natural process in the rocks. Unlike carbon dioxide and ammonia, their slight solubility in water would preclude the supposition that they had been dissolved away. Muck (*Grundzuge und Ziele der Steinkohlenchemie*, 1881) cites analyses of fifty-seven samples of gas from coal mines and of gas occluded in coal. In only one case is carbon monoxide mentioned, but it is distinctly stated that its occurrence was not proved. Ethylene is mentioned in six cases, but Muck states that more recent analyses have failed to demonstrate its presence usually in gas from coal. The absence of hydrogen in all the analyses is especially noticeable. In the case of gases from the Caspian region, the presence of ethylene and carbon monoxide is to be anticipated, as, from all accounts, subterranean heat has been concerned in their production. (See table of analyses.)

Thomas (Watt's Dic., Third Supp., p. 529) gives analyses of fourteen samples of gas occluded by coal and also of gas from blowers in coal mines in New South Wales. The analyses showed the presence of methane, nitrogen, carbon dioxide and oxygen; but no carbon monoxide, hydrogen or ethylene was found. Franke (*J. Pr. Chem.* (2), xxxvii., pp. 101, 113) gives analyses of mine gases, according to which only carbon dioxide and methane were found. Winkler (*Jahresb.*, 1882, p. 1063) found no hydrogen in nine samples of mine gas. Many similar statements might be cited, all tending to prove that hydrogen, ethylene and carbon monoxide do not occur in gases occluded in coal.

The occurrence of gas consisting of nearly pure nitrogen, such as that obtained at Middlesborough, England (see table of analyses), in a region, therefore, where gas similar to Pennsylvania natural gas might be looked for, may perhaps be explained by the action of subterranean water upon deposits of coal or bituminous shale. The dissolved air in such waters, by causing slow oxidation, might lead to the production of carbon dioxide and the consequent removal of oxygen from the water. The carbon dioxide produced would lessen the solubility of the water for nitrogen by causing the water to dissolve carbonate of lime, etc. Gentle heat from below would tend still further to the expulsion of the nitrogen, and thus a considerable but limited quantity of nitrogen might be obtained as a sudden outburst from a drill hole.

| CONSTITUENTS. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Carbon monoxide | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon dioxide | 0 95 | 2·18 | 3·50 | 0 | 2·47 | 4·44 | 0 | 0·3 |
| Olefines | 4·11 | 3·26 | 4 26 | 0 | 0 | 0 | 0 | — |
| Methane | 92·99 | 93·07 | 92 24 | 95 39 | 97·57 | 95·56 | 1·9· | — |
| Hydrogen | 0·94 | 0·98 | 0 | 0 | 0 | 0 | 0 | — |
| Nitrogen | 2·13 | 0·49 | — | — | — | — | 96·57 | 96·8 |
| Oxygen | — | — | — | — | — | — | 1·53 | 2·9 |
| | 100·62 | 99·98 | 100·00 | — | 100·04 | 100·00 | 100·00 | 100·00 |

Nos. 1, 2, 3, 4, 5, and 6, natural gas from the Caspian region. Communicated by letter from Mr. M. Beliamin, of Nobel Brothers, St. Petersburg. No. 4 is the result of a partial analysis. Nos. 7 and 8 gas obtained by deep borings at Middlesborough, England (Bedson, *J. Ch. Soc.*, 1888, p. 662).

But if the chemistry of the reaction supposed to occur is to be considered at all, the fact that distillation experiments have produced from fish oil certain bodies found in natural gas (paraffins) should not count more forcibly as geological evidence than the other fact that such distillation yields bodies which are foreign to natural gas as usually found in Pennsylvania.

I have failed to find any data tending to show that organic matter can be subjected to destructive distillation in such a manner as not to yield carbon monoxide and considerable quantities of olefines, together with hydrocarbons of still less saturated character. As a rule, the acetylenes and benzol series appear. Engler's hypothesis involves the supposition that a process of distillation has occurred at moderately high temperatures and at pressures measured by great depth of rock strata.

The carbon dioxide evolved in this destructive distillation must have come continuously into contact with the vast quantities of carbon, which in its various stages of transformation from vegetable tissue to anthracite is so widely distributed throughout the rocks. The reaction $CO_2+C=2\,CO$. which proceeds rapidly at a strong heat and also slowly at lower temperatures, would then probably have occurred wherever the temperature was sufficiently high.

Prolonged contact of carbon dioxide with the carbonaceous residue of the distillation would perhaps be sufficient to increase considerably the final yield of carbon monoxide.

According to I. L. Bell ("Chemical Principles of the Manufacture of Iron and Steel," p. 101), the reduction of carbon dioxide to carbon monoxide by carbon in the form of soft coke begins at 427° C.

This is about the temperature at which Engler's distillation experiments were conducted (360°–420° C.)

Engler has shown that distillation of animal fats at very high pressure (25 atmospheres) may yield gas containing less of carbon monoxide and olefines than when the process is conducted under atmospheric pressure. No data are at hand as to results at still higher pressure.

If it is conceded that the proportion of carbon monoxide and ethylene in the gas evolved during destructive distillation decreases progressively with increase of pressure, and that these two constituents vanish altogether at sufficiently high pressures, it would still seem necessary to suppose that the pressure must have been at least twice as great when the process occurred in the rocks as in the case of Engler's experiments.

Taking the specific gravity of the rocks to be about 2½, it may be assumed that 12 ft. of rock strata represent a pressure of one atmosphere, 600 ft. of solid rock would then be required to produce a pressure of 50 atmospheres. This would be considerably less than the depth of the same quantity of rock material in the form of loose sediment, before its consolidation. No case can be cited in recent times where sediment 600 ft. deep has been so suddenly accumulated as to bury unchanged the vast quantities of animal remains necessary to account for the production of oil and gas upon Engler's hypothesis that oil and gas have resulted from the action of pressure and moderate heat upon animal matters.

There is probably no reason to suppose that the gaseous olefines have, under the influence of pressure, given place to others of higher boiling point, by a process of polymerization. Should the possibility of such a change be proved, the absence of olefines from natural gas and their presence in petroleum might be explained. The possibility of secondary reactions among the constituents of a complex gas mixture at high temperatures and under pressure adds difficulty to the problem, and caution is needed to avoid the error of overestimating the importance of any given reaction.

It is generally true, however, that under such conditions secondary changes are probable, and that unsaturated compounds—olefines, acetylenes, carbon monoxide—are likely to result, especially when water vapor and carbon dioxide are present.

It is a well-known fact that when petroleum is distilled, considerable quantities of unsaturated hydrocarbons are produced which did not exist in the original crude oil. This is shown by the bromine absorption of the different products. The process of "cracking" or breaking up by heat of the hydrocarbons in petroleum into simpler and less saturated compounds is familiar to all oil refiners. Chemically speaking, cracking means the production of unsaturated hydrocarbons.

The fact that Engler has, in his extremely interesting and important researches, produced by distillation of animal matters so great a variety of paraffins, constitutes by far the strongest argument in favor of his hypothesis.

Sorge, in an article which has been reproduced in numerous journals (*J. Ch. Soc.*, 1888, p. 31, abstract), has stated that a strong resemblance exists between Pennsylvania natural gas and gas manufactured from Westphalian coal. Similarity in composition between natural gas and coal gas would greatly simplify the problem of origin, and the fact of such similarity would prove of great interest.

In this connection, the following analysis of gas from Westphalian coal, carried out in the laboratory of the Westphalia Berggewerkschaftskasse, in Bochum, will be of interest. I am indebted to Mr. Bergassessor E. Krabler, of Bochum, for the figures which he has kindly communicated by letter.

| | 1 | 2 |
|---|---|---|
| Hydrocarbons, $C_nH_n$ | 5 | 4 |
| Methane | 45 | 35 |
| Hydrogen | 40 | 50 |
| CO | 5 | 5 |
| $CO_2$ | 1 | 3 |
| Nitrogen | 4 | 3 |

The large percentage of hydrogen and the proportion of CO in this gas illustrate at once the results of high temperature in the production of coal gas, but a similarity between this coal gas and natural gas can hardly be said to exist.

When vegetable remains are buried under water, as is well known, decomposition occurs, yielding gas in considerable quantity.

Tappeiner (*Ber.*, 1883. p. 1734) has studied the products of this change very exhaustively.

Pure cellulose (filter paper) was found, under the influence of a microbe, which was supplied with nutritive fluids, to dissolve in water, yielding gas mixtures of two different types.

| | Under Water of Neutral Reaction. | | Under Slightly Alkaline Water. |
|---|---|---|---|
| | At Beginning. | | At End. |
| | Per Cent. | Per Cent. | Per Cent. |
| Carbon dioxide | 85·48 | 76·98 | 55·39 |
| Hydrogen sulphide | | | |
| Hydrogen | 0·0 | 0·0 | 42·71 |
| Methane | 11·86 | 23 01 | 0·0 |
| Nitrogen | 2·73 | 0·0 | 1·90 |

From these experiments it appears that by the action of a microbe either methane and carbon dioxide (neutral fluid) or hydrogen and carbon dioxide (alkaline fluid) may result. Hoppeseyler (*Ber.* 1883, p. 122) found that gas evolved in the decay of cellulose under the influence of a microbe (marsh gas fermentation) contained:

| | Per Cent. |
|---|---|
| Carbon dioxide | 50 |
| Methane | 45 |
| Hydrogen | 4 |

Popoff finds in a gas from decaying vegetable matters:

| | Per Cent. |
|---|---|
| Marsh gas | 68·56 |
| Carbon dioxide | 31·44 |

Berthelot states that hydrogen is produced in the vinous fermentation of mannite. In very careful experiments which I have tried I have failed to find hydrogen in the gas evolved during the fermentation of 200 grammes of sugar. Chemical changes of this type are not likely to be of importance, however, as regards the hydrogen question.

*Gases from Sea Weeds.*—The following experiments were tried in order to study the nature of the gases evolved in the decay of sea weeds:

A quantity of a large fucus kind from Santa Barbara, Cal., was used. Fifty grammes of the air-dried plant were soaked in water and then introduced into a flask filled with water which had been previously boiled (in order to expel air) and cooled. The flask was connected with a bell jar over a mercury trough. After setting up the apparatus, no gas appeared until the third day; then a strong evolution of gas began and continued in slowly diminishing quantity ten days, when the process ceased. In all, 803 cubic centimeters of gas were collected. Analyses were made (1) of the first portion of 300 cubic centimeters, (2) of a second portion of 300 cubic centimeters, and (3) of the last portion of 203 cubic centimeters. The results are tabulated below:

| | First Portion Per Cent. | Second Portion Per Cent. | Third Portion Per Cent. |
|---|---|---|---|
| Carbon dioxide | 18·23 | 32·47 | 53·44 |
| Carbon monoxide | 0 | 0 | 0 |
| Ethylene | 0 | 0 | 0 |
| Methane | 0·30 | 0·28 | 0·08 |
| Hydrogen | 62·24 | 48·97 | 42·02 |
| Nitrogen | 19·23 | 18·28 | 4·46 |
| | 100·00 | 100·00 | 100·00 |

Carbon dioxide was determined by soda solution over mercury; hydrogen by palladium asbestos, using a Hempel apparatus. The absence of CO and $C_2H_4$ was proved by palladium chloride solution. Methane was determined by combustion with air, using a red-hot platinum tube. The carbon dioxide produced in the combustion was absorbed by baryta solution of known strength, and the excess of baryta determined by standard oxalic acid. The following facts are of especial interest:

1. The carbon dioxide increases toward the end of the decay.
2. The hydrogen steadily diminishes.
3. Methane occurs only in traces.
4. Nitrogen occurs in such considerable quantity as to render it probable that this gas is set free in the process of decay.

The same apparatus was kept in position for 2½ years after the above experiments were finished. During that time a continuous production of gas was observed, but it was so slow that at the end of this period only about 30 cubic centimeters of gas collected. This was found to consist of methane

I have examined the gases produced in swampy ground in many different places. Samples were taken from streams having muddy bottoms and in which vegetable matter had collected. Samples of gas have also been taken from salt marshes on the coast of Maine.

Gas has also been collected from the very deep accumulations of mud and decaying vegetable remains found in some parts of Lake Chautauqua. The general result of examinations of these gas samples may be stated to the effect that the gas occurring in shallow swamps and streams consists of methane, carbon dioxide, and nitrogen.

In some of the much deeper swamp waters, where masses of vegetable debris of greater thickness are found (as in Lake Chautauqua), hydrogen occurs in very small quantity. Great difficulty is experienced in taking samples of gas from localities of the latter type. Tappeiner observes that the marsh gas fermentation is probably a very important source of methane in nature.

The fact that buried vegetable matters may, after a brief period of rapid gas evolution, pass into a condition of extremely slow decay adds greater force to the original theory of petroleum and gas. The occurrence of so large a proportion of free hydrogen among the gases evolved by vegetation in process of decay is a matter of great interest, as it suggests the existence of an important source of hydrogen wherever deeply submerged plant remains occur. Frankland (*J. Ch. Soc.*, 1883, p. 295) found that grass left to decay under water (air being excluded) evolved gas in three days of the following composition:

| | Per Cent. |
|---|---|
| Carbon dioxide | 84·63 |
| Oxygen | 0 13 |
| Hydrogen | 6·90 |
| Other combustible gases | 2·51 |
| Nitrogen | 5·83 |

Vegetable tissue, after the somewhat sudden and tumultuous evolution of gas, seems to be capable of relapsing into an extremely slow and long-continued process of decay. After the first decomposition, such remains might become accumulated and buried deeply under sediments before the tissues are materially altered.

The generation of gas might proceed in the cold. It seems hardly possible to ignore this probable source of natural gas in discussing any theory as to its origin, especially when it is considered that no other process in nature has been found to yield a gas at all similar in composition to that found in the rocks.

Of the three hypotheses which have been proposed

to account for the production of oil and gas, two are open to a serious objection.

The chemical changes supposed by Engler to have been the cause would probably yield gas different in composition from the natural gas now being obtained in such large quantity in Western Pennsylvania, and if the gas originally contained ethylene and carbon monoxide, it is not easy to explain their complete disappearance in the natural gas I have examined from wells scattered over so large a region.

The hypothesis of Mendeleeff would be much more difficult to reconcile with the facts as regards composition. The total absence of hydrogen could not be easily explained. The only process in nature which is known to yield gas similar in its constituents to natural gas is that which occurs in swamps and decaying masses of submerged vegetable remains.

The important fact that the solid plant tissues may be preserved for long periods after the preliminary gas evolution has ceased shows that the remains are likely to become slowly buried, to undergo the fermentation changes leading to the production of methane.

Animal tissues can suffer no such arrest of decomposition. Decay once set in is carried rapidly onward to complete destruction without intermission. The contrast between the conditions in which animal and plant remains occur in the rocks seems to justify this statement.

If chemical evidence shall count in the discussion, it is difficult to find a more satisfactory explanation than the older hypotheses which the geologists advanced, although in their treatment of the subject the strictly chemical arguments were neglected.

[From Nature.]

## THE PLANET VENUS.

From time immemorial the planet Venus has attracted the attention of mankind. Before the days when the "optic tube" began to be turned toward her disk, Venus, we might say, was still in myth, and she was hailed as Hesperus and Phosphorus, according as she was an evening or a morning star, the fact that the same object was in question being then unknown.

Shining as she does at times with a brilliancy surpassing any other body except the moon, it is only natural that she should have been so often sung about by poets in all lands, liking her unto

"the fair star
That gems the glittering coronet of morn."

And she is highly honored by Homer, in that she is the only planet to which he refers:

*Ἔσπερος ὃς κάλλιστος ἐν οὐρανῷ ἵσταται ἀστὴρ.*

Hesperus quæ pulcherrima in cœlo posita est stella.

To Galileo belongs the honor of first having viewed the planet through a telescope, but it is curious to remark the lapse of time that he allowed to pass before he made his first observation. The discovery that Venus exhibited phases did not take place until the end of September, 1610, though Galileo first observed the satellites of Jupiter on January 7 of that year.

That Galileo should veil this important discovery of the phases of Venus under a Latin anagram* does seem at first rather strange, but when one considers the vast importance of the discovery in that it supplied a simple proof of the planet's revolution round the sun, one can understand that he would first desire to be quite certain of his facts before giving the key to the anagram.

An historical fact of interest with reference to Father Castelli may be mentioned here. In Venturi's collection there is a letter from Father Castelli to the celebrated Florentine astronomer, dated November 5, 1610, in which he asks Galileo whether Venus and Mars show phases. Galileo evidently did not wish to give a direct answer, so evaded the question by saying that, although he was engaged in various investigations, he was better in bed than out in the open air in consequence of great infirmity. It was not until December 30, 1610, that he informed Castelli of his recognition of the cusps.

With an ever-increasing number of telescopes at the disposal of astronomers, it is not astonishing that facts concerning surface markings, form, period of rotation, etc., should be rapidly forthcoming, and the sum total

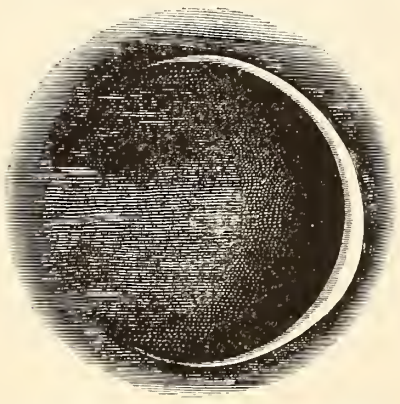


Fig. 1.—February 26, 1878 (Trouvelot).

of what we now know about the planet has been gained at the expense of much labor and patience at the eyepiece end of the telescope.

During the past three months Venus has been a striking object in the southwestern and western region of the sky, being in a position more than usually favorable for observation. Toward the end of November last her great southern declination began to decrease, while the planet became brighter and brighter, passing her greatest elongation east on December 6. On January 11 she attained her maximum brilliancy, the crescent form gradually increasing until on February 15, that is, at inferior conjunction, it was totally invisible. Gradually the crescent will become visible again, but in the inverse order, and we shall have another maximum on March 22, superior conjunction occurring on November 30. Thus we know that Venus is now lost in the sun's rays, and is, in consequence, invisible to us as evening star for some time to come. The accompanying illustration (Fig. 1) gives a drawing of the planet as recorded by Trouvelot in 1878, at a time when only a very fine crescent was visible. (The bulging at the south-southeast portion of the crescent was observed, and is not a defect in the drawing.)

Of all the planets, Venus approaches us the nearest, her minimum distance amounting sometimes to approximately five million miles, that is, about five times nearer than when she is furthest from us. Unfortunately, at these times her illuminated disk is turned away from us, and all we can do is to direct our atten-

Fig. 2.—Details of Snow-caps January 19, 1878 (Trouvelot).

tion to the small crescent that remains before inferior conjunction is reached. This accounts for the uncertain knowledge that we possess with regard both to surface markings and the period of rotation. The latter question is still a moot point among astronomers, and it is interesting to note the historical sequence in which these investigations have been made. The first spots on the planet's disk were noted by Dominique Cassini in October and June of the years 1666 and 1667 respectively, and from them he deduced a period of 23 h. 21 m. Bianchini, about 60 years afterward (1726–27), came to quite a different result, substituting 24 days 8 hours for that obtained above. Jacques Cassini, discussing his father's observations and those made by Bianchini, concluded that a period of 23 h. 20 m. satisfied both the old and new observations, but that Bianchini's value would not agree with that of his

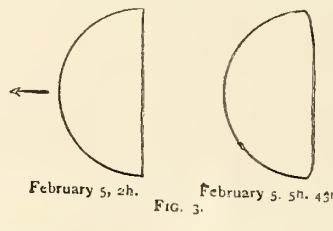



Fig. 3.

father. This value seems for some time to have been accepted, and Schroeter's (1798–99) and De Vico's (1840–42) observations practically confirmed it. Fig. 2 gives a view of the planet as seen on January 19, 1878, and shows the details in the polar spots sometimes available for "period of rotation" determinations.

Thus matters stood till that keen-eyed observer Schiaparelli took the field. After a most careful study, extending over many years, in which some single observations were made extending over eight consecutive hours, he was led to make the statement that the rotation of the planet is exceedingly slow, and probably takes place in a period of 224 days 7 hours, the duration of the revolution of Venus about the sun. At Nice, M. Perottin has come to a similar view, expressing his opinion in the following words: "Ne diffère pas de la durée de la revolution sidérale soit 225 jours environ, de plus de 30 jours." These two observers, especially

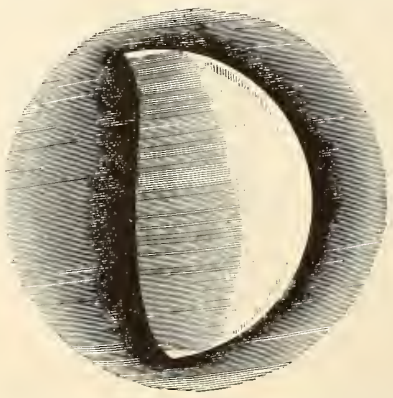


Fig. 4.—Showing Irregularity of Terminator November 23, 1877 (Trouvelot.)

the former, thus upset our whole belief in a short duration of the period, but we are still again brought to consider the question from observations emanating from another source. We refer to those made by Prof. Trouvelot (see *Nature*, vol. xlvi., p. 470), whose opinion is of great weight.

The importance of his work lies in the fact that it was carried on at the same time as that of Schiaparelli "souvent dans la meme journée, sous un ciel également propice et précisément sur la meme point de la planète." The value ultimately deduced was 23 hours 49 minutes 28 seconds, which again brings us back to a short period. In referring to Schiaparelli's observations he says: "La cause probable de l'erreur de M. Schiaparelli semble résulter de ce fait que les taches *h* et *k*, qui ont servi de base à ses conclusions, faisaient partie de la tache polaire méridionale qui, étant située centralement sur l'axe de rotation de la planète, semble rester stationnaire, comme cela se voit sur la tache polaire de Mars, quand elle se trouve réduite à de faibles dimensions." He also refers to the general features visible on the planet's surface as indications of a rapid rotation, especially that of the rapid deformations of the terminator and hours.

Thus we are left with the choice of two periods, one long and consisting of 224 days, the other short, of 24 hours nearly. We leave our readers to adopt that which they think best, the balance of favor falling, in our opinion, slightly toward the 24 hour side of the scale. But just as Schiaparelli's observation of the doubling of the canals of Mars was finally observed and universally accepted, so perhaps time may prove his case as regards this period of rotation.

Some of the most recent work on the planet Venus relates to the measurement of her diameter. Among a few of the reduced measures the following may be given: Hartwig, with the Breslau heliometer, from forty-three observations obtained a diameter of 17″·67. The same observer, from a reduction of the Oxford observations, and also from Kaiser's observations with Airy's double image micrometer, obtained 17″·582 and 17″·409 from thirty-three and thirty-four observations, respectively. Auwers from the transit of Venus measures deduced the value 16″·801, while Ambronn,* from thirty-four observations, measured the diameter as 17″·711.

Among other interesting points to which we might refer are the planet's visibility in full daylight, the snow caps, the secondary light, the planet's form, etc. Each of these has raised a host of questions at various times, which even yet are not fully answered. The question as to the form of the planet itself is also one full of interest, and observers, from Beer and Madler down to Trouvelot, have made numerous drawings of the different appearances. Observations have shown that the surface, or whatever it is that we look at, is by no means level, but extremely uneven or irregular. Such irregularities can be best detected naturally at the terminator and limb. Fig. 1 indicates a bulging at the limb, while Fig. 3 shows a similar phenomenon at the terminator at two different times—February 5, 2 h. and 5 h. 43 m. (Perhaps this is one of the best proofs of a "short duration" period for rotation.)

Fig. 4, which we also owe to Prof. Trouvelot, shows a more decided case of irregularity, and on perhaps a much larger scale.

Much remains, however, to be done before we are on anything like a footing with this planet as we are with Mars. With this latter we can observe directly the land and water markings, time to a second the period of rotation, observe local storms, and many other details; but with the former the case is different. Here the planet is for the most part lost in the rays of the sun, or at other times not very easy for observation.

That Venus has an atmosphere is a fact which has long been known, and that this is denser than the earth's envelope is also very probable. The part this atmosphere plays in the determination of the period of rotation seems to be of great importance, and it is rather a question of whether we have been observing real rigid markings on the planet itself, or only what has been described as "a shell of clouds, the appearances interpreted to signify the existence of lofty mountains, snow caps, vast chasms, and crater-like depressions, are really nothing but the varying features of cloud scenery."

Whichever the case may be, future observation has still to show; but it seems that with the rapid advance now taking place in large instrument making, such a question as this could be settled, given a few fine evenings or mornings near a favorable time of observation, a clear and still air, and a large aperture. Such occasions, perhaps, may be rare, but the point at issue is important, and should be settled as soon as possible.

W. J. L.

## THE MEGALADAPIS.

### A GIGANTIC LEMURID RECENTLY DISCOVERED IN MADAGASCAR.

The great African island of Madagascar, the area of which exceeds that of Italy, is, like Australia, a true continent, or rather the remains of one, very distinct in its fauna from Africa, of which it is so close a neighbor from a geographical point of view. This fauna is especially characterized by the presence of numerous Lemuridæ or makis, quadrumanous mammals, called also lemurs and false or fox-nosed monkeys, and which here replace the true monkeys that are so numerous in Africa. We find, indeed, a few Lemurids in Africa and in Malaisia, but they seem to be isolated there, and as if lost in the midst of a fauna of an entirely different character. In Madagascar, on the contrary, they form two-thirds of the mammiferous population, and it cannot be doubted that they are located in their true country.

We find also on this island a very curious cat, the *Cryptoproctus*, which is a plantigrade, while all the other cats distributed throughout the entire world, with the exception of Australia, are digitigrades.

Finally, Madagascar is destitute of indigenous ruminants.

These zoological peculiarities give this island a feature of oddness almost as great as that which distinguishes Australia. In order to find a fauna comparable with that of this island we must go back to the ancient geological ages and examine the fossils that characterize them. We find, then, not without surprise, that in Eocene and Miocene times, that is to say, at the beginning of the great tertiary period, animals similar to those that still live in Madagascar stocked the forests of the country now called France. The Carnivore, whose remains are found in the Eocene of Quercy and the Miocene of Saint-Gerard-le-Puy, and which Mr. Filhol has named *Proailurus*, scarcely differ from the *Cryptoproctus* of Madagascar. So, too, the small mammals that existed at the same epoch in France, and whose bones have been described under the names of *Adapis* and *Necrolemur*, were tree-inhabiting quadrumana very nearly akin to the makis of Madagascar, in a word, true Lemurids. Such approximation is not one

* "Hæc immatura a me jam frustra legentur," or with the letters properly arranged—"Cynthiæ figuras æmulatu Mater Amorum."

* See *Astr. Nachr.*, No. 3204, p. 190.

of the least surprises that science has prepared for us. Thus Madagascar has, up to the present epoch, preserved an Eocene fauna, just as Australia still possesses a cretaceous, that is to say, secondary one.

From what has just been said, it will be seen how interesting it would be to know the geological faunas that preceded that which still exists in Madagascar. These ancient faunas, however, are almost entirely unknown to us, despite a few isolated discoveries well calculated to excite the zeal of paleontologists.

In 1851, in fact, that is to say, more than forty years ago, there were discovered in some relatively recent strata in Madagascar some eggs of huge size (of a capacity of two gallons) along with the bones of a bird that must have laid them, and which Geoffroy Saint-Hilaire designated with the name of *Æpyornis maximus*. It was an *Apteryx* nearly ten feet in height, the most massive of all known birds, since in this respect it exceeded the *Dinornis*, which was more slender. In the same strata were discovered later on the remains of a hippopotamus (*Hippopotamus Lemerlei*) different from those that exist in Africa. This is about all that we know concerning the ancient fauna of Madagascar. A long interval had to elapse before any new discoveries should be made. Very recently, however, these paleontological researches have been resumed with new ardor, and this time with more encouraging results. The fossil remains that are found, especially in the ancient, partially dried marshes that abound in certain parts of Madagascar, are very abundant, and it seems as if the study of them ought to throw an entirely new light upon the ancient fauna of the great island of the Indian Ocean.

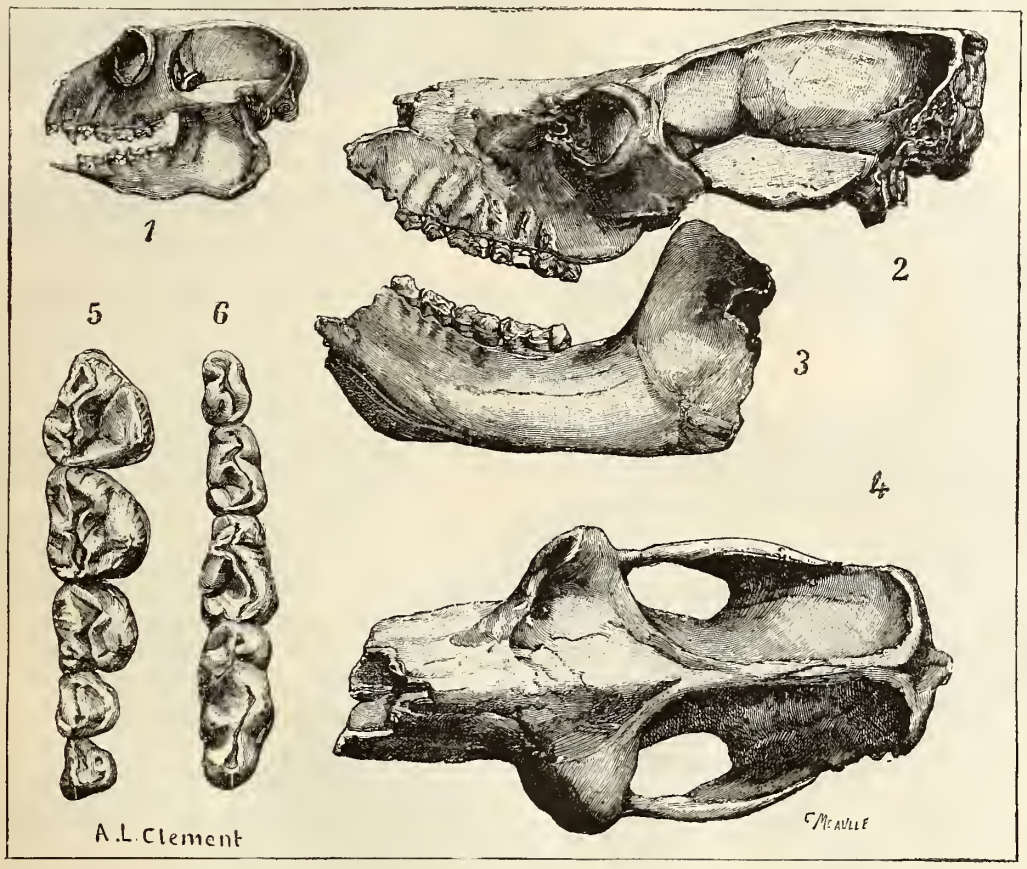



FIG. 1.—SKULLS OF THE INDRIS AND MEGALADAPIS.

1. Skull of indris (×⅓). 2 and 3. Skull and lower jaw of megaladapis (×⅓). 4. Skull of megaladapis seen from above. 5 and 6. Upper and lower tooth of the same (of natural size).

The most remarkable of such remains is the nearly complete cranium of a large Lemurid of an extinct species, which Mr. Forsyth Major, the well known paleontologist, has described under the name of *Megaladapis Madagascarensis*.

As well known, the Lemuridæ that now inhabit Madagascar are all small or of medium size. The largest of them, the short-tailed indris (*Indris brevicaudatus*), called by the Malgaches "man of the woods," and which we represent herewith (Fig. 2) for the sake of comparison, attains scarcely three feet in height when it stands upright upon its hind feet. Its skull is no larger than that of a fox.

FIG. 2.—SHORT-TAILED INDRIS OF MADAGASCAR.

The *Megaladapis* was three times larger, thus giving this great Lemurid the stature of the orang-outang or gorilla, but with a very different aspect and very different proportions, according to all appearances.

In Fig. 1 we represent the skull of this animal reduced to a third of its natural size. Alongside of this is placed the skull of the indris reduced to the same scale, thus permitting one to obtain an idea of the real dimensions of the *Magaladapis*. The teeth of the latter are figured of natural size. It will be seen that they are stronger than those of man and comparable to those of the gorilla. Finally, the head of the indris, a front view of which of natural size is shown in Fig. 3, gives us an idea of the physiognomy that a Lemurid three times larger must have possessed.

The skull of the *Megaladapis* is 8 inches in length, and, as the anterior part is broken, it will be seen that the head of the living animal must have exceeded that length. The width at the orbits is 4½ inches. The last upper molar is more than 7-10 of an inch in its greatest diameter, and the corresponding lower molar, which is greatly elongated, is more than an inch in diameter.

The Lemuridæ of the present epoch are characterized by their orbitar frame forming a complete circle in front, although the cavity of the orbit communicates widely behind with the temporal fossa, this distinguishing them from the monkeys, in which this communication is closed, as in man, by the consolidation of the frontal bone with the sphenoid and malar bones. Besides, the lachrymal duct is situated outside of the orbit, and not within, as in man and the monkeys. Notwithstanding the elongation of the muzzle, the dentition is quite similar to that of the American monkeys, but the lower incisors point outwardly and are sometimes reduced to two, as in the indris. The dentition, moreover, varies much from one genus to another, and the adult, through the effect of age, often loses one or more pairs of teeth that are present in the young, so that the dental formula of the latter is always more normal than that of the adult.

The *Megaladapis* presents the cranial and dental character of the Lemuridæ, but modified in a very special manner and of which no example is known among the living species.

What strikes us at first sight when this skull is examined alongside of that of other Lemuridæ is the narrowness of the cerebral case, which seems out of proportion with the elongation of the facial region, and the strength and heaviness of the jaws. The present Lemuridæ have, indeed, an elongated muzzle (like that of a fox), but their skull is always much more rounded and inflated behind than that of the *Megaladapis*. The cerebral cavity of the latter is no more than three inches in length, so that the brain of this large Lemurid was no larger than a hen's egg. It is the ordinary size of the brain of the indris, whose skull is three times shorter. Now, it appears that the indris possesses only quite a moderate amount of intelligence. If we admit that the intelligence is always proportionate to the development of the brain, we may conclude therefrom that the *Megaladapis* was a pretty stupid animal. On the contrary, it must have possessed great muscular strength. The skull that we have before us must have afforded an attachment to powerful muscles. The saggital crest that occupies the summit of it, the very large zygomatic apophyses, the deep temporal fossa, and the size of the teeth are an evident proof of this. In its entirety, this skull recalls that of the large monkeys, such as the baboon, the chacma, and the mandrill, the stature of which approaches that of the anthropoids and which have also a greatly elongated head and a huge jaw, which has given them the name of *Cynocephali* or dog-headed monkeys. The *Megaladapis* was a cynocephalous or dog-headed Lemurid, at least at the adult age, for, like the monkeys, the young must have had a more rounded skull and borne more resemblance to

FIG. 3.—HEAD OF INDRIS (Natural size).

the other Lemurids. The orbits of the *Megaladapis* are remarkable by their form, being quite different from that of the makis. The latter, almost all nocturnal, have very wide orbits directed outwardly, almost touching upon the median line. Here, on the contrary, the orbits are very wide apart, and lateral or directed obliquely, forming a sort of funnel—an arrangement found again, up to a certain point, in the indris. The eye of the *Megaladapis*, instead of being large and prominent, as in the present Lemuridæ, must have been sunken and protected by the orbitar frame, a conformation that indicates habits less truly nocturnal than those of the present Lemurids.

The teeth of the upper jaw (the three premolar and three posterior molars) all have three turbercles, two external and one internal, but it is easy to see that this latter is formed by the fusion of two tubercles. This, however, is quite common in the Lemurids, some of which have molars with four tubercles, as the indris, while others, and particularly certain species of small size (of the genera *Lipilemur* and *Cheirogaleus*), have but three. As in these small species, the *Megaladapis* presents a last molar as strong as the one next to the last, while the posterior tooth is notably reduced in the indris and the makis properly so called. The lower molars are of the ordinary four-tubercled type, except the last, which has five tubercles and is much elongated in consequence of the presence of this fifth tubercle, forming a spur. This lower posterior molar, elongated and with five tubercles, is observed in the *Lepilemur* and in the fossil *Adapis*. It exists also in the cynocephalous monkeys, in the *Oreopithecus*, a large monkey of the tertiary of Italy, and is found again in the omnivorous ungulates of the group of hogs.

The front teeth are wanting in the upper and lower jaw which we figure and which are fractured at the point of insertion of the canines. From an examination of what remains, it is probable that these canines were of middling size, as in most of the Lemurids. The form of the symphisis of the lower jaw, which is very high and very strong, proves that the lower canines and incisors were almost straight and not slanting like those of the indris and other Lemurids.

The *Megaladapis* presents several points of resemblance with the *Adapis* of the tertiary of France, particularly with the *Adapis magnus*. Such are the presence of a saggital crest and the form of the orbits and that of the teeth of the lower jaw, etc.

This type undoubtedly belongs to the order of Le-

murids, but, with Mr. Forsyth, we think that it ought to constitute a family apart, akin to but distinct from that of the present Lemuridæ. In every respect, it is a very specialized type, which, after it has become better known, will doubtless form a new link connecting the Lemurids with the Ungulates. We know that Mr. Milne-Edwards has shown that the makis, by their internal organization, are closely related to the Suidæ, and we may recall the fact that Cuvier described the *Adapis* as a small ungulate akin to the daman. It is not impossible that the *Megaladapis* was a Lemurid on the way to a transformation toward the type of the Ungulates, the same as the aye-aye or *Cheiromys* is a Lemurid that is becoming transformed under our eyes into a rodent.

The skull of the *Megaladapis* came from the same marsh of Ambolisatra in which not long ago were found the remains of the *Æpyornis* and hippopotamus of which we have already spoken. The geological strata are of recent origin, for we find therein the bones of the domestic ox introduced into Madagascar by man. All the bones have that modern aspect which paleontologists characterize by saying that they are subfossil, and several exhibit traces of the hand of man.

The *Megaladapis* has however a well-marked tertiary aspect, and this is the first time that a fossil mammal so different from all the mammals now living has been found in Madagascar. We can scarcely doubt, however, that this large Lemurid lived at a relatively recent epoch,and was hunted and eaten by the first men who introduced the domestic ox into Madagascar.

What gives much weight to this opinion is the following passage from Flacourt, the first historian of the great African island, and which seems to refer to the *Megaladapis* or to some large Lemurid closely related to it:

"The tretretretre, or tratratratra, is an animal as large as a two-year-old calf, and which has a round head and a man's face; the fore-feet like those of a monkey, and the hind ones also. It has curled hair, a short tail and ears like those of a man. It resembles the tanache described by Ambroise Paré. It has been seen near Lake Lipomani, in the vicinity of which is its lair. It is a very solitary animal that the people of the country hold in great fear and run away from, as it also does from them." *

With the exception of the round head and the size, which is doubtless exaggerated, this description by Flacourt applies to the *Megaladapis* very well. If we reflect, moreover, that the head of the living animal must have been covered with one of those shocks of curled hair which, in the present Lemurids, greatly increase the volume of it behind the ears, it will be agreed that there exists at least a singular coincidence between this description and the discovery recently made in Madagascar. The data given by Flacourt as to the fauna of the island are, as a general thing, very accurate, and most of the animals that he describes have been found by the naturalists who have succeeded him. It is therefore permissible to believe that rare survivors of this large species of Lemurid were still living, "very solitary," as he says, at the epoch of his sojourn in Madagascar—that is to say, in the middle of the seventeenth century.

However this may be, an examination of the skull of the *Megaladapis* permits of representing the latter as a Lemurid of a size comparable to that of a mandrill, and, like the latter and the indris, destitute of a tail. Like the cynocephalous monkeys, it must have inhabited mountainous and rocky districts and have oftener remained upon the ground than in trees. It ascended the latter only to obtain its food, which must have consisted of small birds, leaves, and fruit. Its strength must have been very great, and when it was attacked, its teeth and its robust arms must have rendered it formidable to man himself. But its intelligence was of a low order, so that it was easily exterminated by the population (probably of Malaisian origin) that colonized Madagascar, and that seized every opportunity of killing it with spears and *sagaies* in order to feed upon its flesh. We can wait to soon possess new data in regard to this large Lemurid and to the other mammals, now extinct, that constituted the tertiary fauna of Madagascar. Among the bones recently sent from this island to the Museum of Paris, and a description of which will be given by Mr. Milne-Edwards, there is a humerus that might well have belonged to the *Megaladapis.—E. Trouessart, in La Nature.*

## ACTION OF LIGHT ON BACTERIA.†

By Prof. H. M. Ward, F.R.S.

A thin film of gelatine or agar, in which spores or bateria are evenly distributed, is spread over the flat bottom of a shallow glass dish. The lid of the dish is a plate of ground glass, in which one or more slots, about ½ inch wide and 2½ inches long, are pierced. The spectrum is so arranged that the light rays fall perpendicularly on the film carrying the spores, etc., and can only reach the latter through the slots, all other parts of the plate being covered by tin foil and black paper.

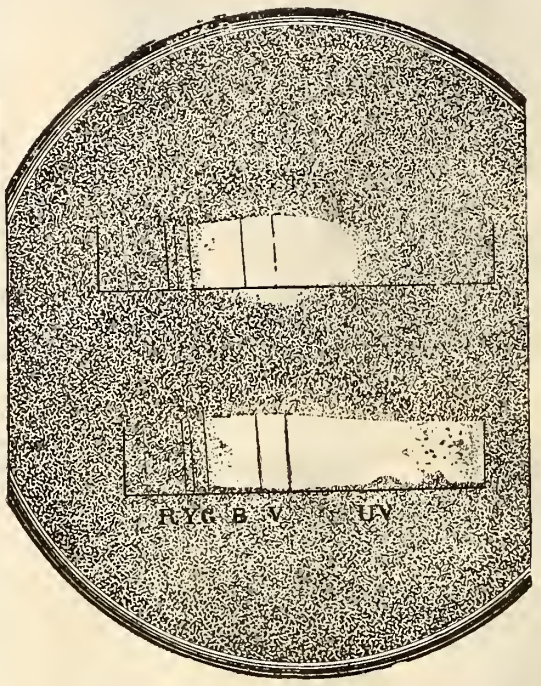
When the film has been thus locally exposed for a certain number of hours to the spectral rays, the culture is put into the incubator. All those parts protected from the light entirely behave as in any ordinary culture—the spores germinate out and develop colonies, and the previously transparent film (transparent because the spores are too minute to affect it) becomes opaque.

Under the slot, however, the spores were exposed to the various rays of the successive regions of the spectrum. On one part of the exposed area the infra-red rays fall; on another the red, on another the orange, and so on with the yellow, green, blue, violet, and ultra-violet rays.

If any of these rays kill or injure the spores they fall on, obviously the latter will show the effect by not germinating at all in the incubator, after exposure, or by germinating more or less slowly and feebly in comparison with the uninjured spores.

Wherever the spores do not germinate at all, the gelatine remains transparent; where they only germinate and develop into slowly growing, feeble colonies, the transparency of the gelatine film is merely clouded more or less; whereas where they germinate and develop as vigorously as on the unexposed parts of the film, the latter is rendered quite opaque.

Obviously these differences, or contrast effects, can be photographed, and the following is a photograph of a plate treated as described.




ACTION OF LIGHT ON BACTERIA.

In all cases so far examined, both the solar and electric spectra show that no action whatever is perceptible in the infra-red, red, orange, or yellow region, while all are injured or destroyed in the blue and violet regions.

The exact point when the action begins and ends is not the same in all the experiments, though very nearly so, but it must be reserved for the detailed memoir to discuss the various cases.

Broadly speaking, the action begins at the blue end of the green, rises to a maximum as we pass to the violet end of the blue, and diminishes as we proceed in the violet to the ultra-violet regions.

Some especially interesting results were obtained with the electric spectrum. In the first place, the results with glass prisms, lenses, etc., were so feeble that it was necessary to employ quartz throughout.

Secondly, the bactericidal effect is found to extend far into the ultra-violet. The intervention of a thin piece of glass results in the cutting off of a large proportion of effective rays.

These results suggest evidently that the naked arc light may prove to be a very efficient disinfecting agent in hospital wards, railway carriages, or anywhere where the rays can be projected directly on to the organism.

## THE ACARI.

At the recent annual meeting of the Royal Microscopical Society, Mr. A. D. Michael, president, delivered the annual address. He took for his subject the growth and present state of our knowledge of the Acari. The name "Acarus" was probably first used by Aristotle; it means uncuttable. But Aristotle did not anticipate Cambridge rocking microtomes, and the president exhibited a set of over 120 serial sections cut from a far smaller Acarus than Aristotle could ever have seen. The president then described what an Acarus really is and in what respects it differs from other Arachnida, a distinction which is erroneously stated in almost all text books of zoology. The classification of the group practically began with Linnæus; it was shown how difficult it is to identify a Linnean species, and the progress of classification was shortly traced from the single Linnean genus to the two hundred and twelve genera admitted by Trouessart, one of the latest writers on the subject. The president then referred to the fact that many of the predatory Acari had not any special organs of vision, and yet that they were most active creatures, and would catch such agile insects as Thysanuridæ without constructing any web or trap, and did not seem to suffer in the least from their eyeless condition; he had seen small and weak Acari quietly waiting until large ones had finished feeding before they ventured to attack the leavings, although both were blind. The various forms of acarine parasitism and commensualism were then described, including one where a parasite lives in the fur of the rabbit, not feeding on the host, but on other parasites which really do so, and the number of these which it will destroy is amazing. The president then illustrated the principal families of Acari by selecting one or two instances of each, which were specially interesting either from their habits, their anatomy or otherwise. The Sarcoptidæ, or bird parasites, were represented by a parasite of the cormorant, discovered by the president, in which the male has one leg much larger than the other; and the skeleton of the body is greatly modified to support it; but the enlarged leg and modified skeleton are on the right side of the body in some specimens and on the left in others. The so-called cheese mites were referred to in order to describe the hypopus stage in the life history of many of them; when the creature, which is originally soft and easily killed by heat or exposure, suddenly becomes hard and able to endure almost all vicissitudes, and also to live for a long period without eating; it is then provided with special organs for adhering to insects, and thus the species are widely distributed under circumstances where they would otherwise perish. The president then spoke of his recent researches into the association between many Acari (Gamasids) and certain ants in whose nests they live, and of a still stranger and hitherto unrecorded case, even more lately observed by him, in which a species of Acarus (*Bdella*) lives habitually in a spider's web in harmony with the otherwise most ferocious occupant. The speaker then shortly described his recent discovery of the extraordinary way in which female Gamasids are fertilized, a spermatic capsule being conveyed to its destination by the mandibles of the male. Finally, the descent of the Acari was discussed.

* De Flacourt, *Histoire de la grande Ile de Madagascar* (1658), p. 154. As to the "tanache," or rather "thanaeth," of Ambroise Pare, the description of which is found in the book on *Des Monstres tant terrestres que marins, avec leurs Portraits*, the passage that refers to this animal is marred by fabulous traits that we are surprised to find coming from the pen of the great surgeon, so full of learning and good sense in the rest of his writings. We see, nevertheless, that it is a question of a large anthropoid monkey, probably of a chimpanzee, carried on board of a ship commanded by Andre Thenet in his voyage through the Red Sea. (Cf. A. Pare, *Œuvres Completes*, Malgaigne edition, 1840, t. *III.*, p. 786.)

† Lately read before the Royal Society.—*Nature.*

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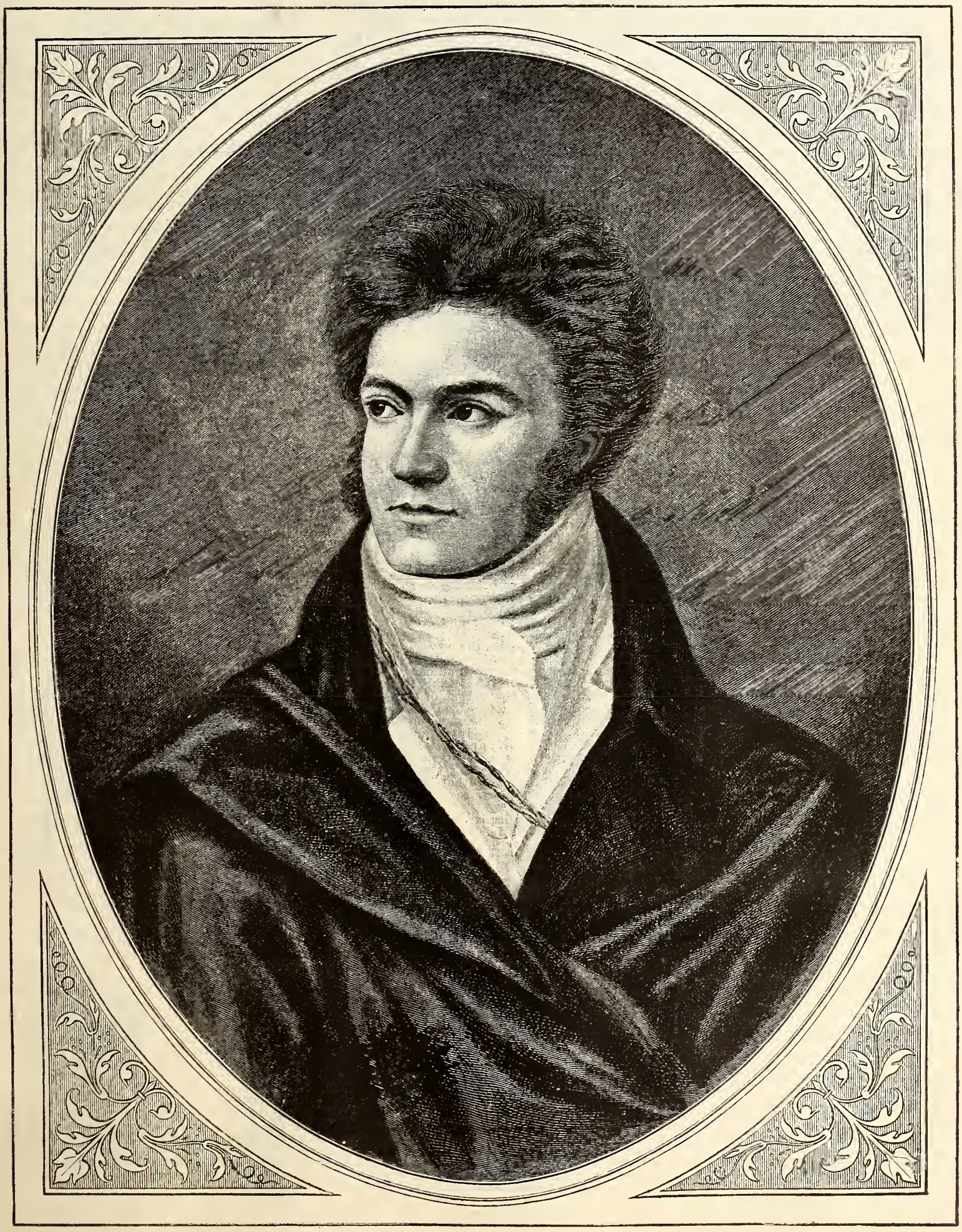
## A BEETHOVEN PORTRAIT BELONGING TO THE HOUSE OF BRUNSWICK.

It is most remarkable that a new portrait of Ludwig von Beethoven should have been discovered at this late day, after so many careful investigations into the life of the great master, so many jubilees on his anniversaries, and so many exhibitions of objects connected with his memory. The discovery will especially delight his admirers, because it is a very good oil painting of nearly life size, and fills a gap in the iconography. Here we have Beethoven in the prime of life, about thirty-four years old, for the picture must have been painted in 1803 or 1804. This was the time of Beethoven's life that came between a youth in which



A NEWLY DISCOVERED PORTRAIT OF BEETHOVEN

there was little joy and the development of that tragic deafness which gave its fatal warning as early as 1800—certainly the happiest period that he had known. Originality and certainty of success are stamped on this countenance, in which we find all the characteristic peculiarities which we have learned to know from the later portraits; the forehead angular, the lower part of the face projecting on account of the peculiar placing of the teeth, the ugly nose, and the hint of a dimple in his chin, which afterward became so pronounced. The picture also shows the disheveled hair, a characteristic neglect of the master and his disciples, which, however, is here counterbalanced by a certain care in the arrangement of the dress. Thus, and not otherwise, must we think of Beethoven when he appeared in the brilliant circle of Austrian nobility.

Unfortunately, the painter of this portrait, which is well preserved, with the exception of parts of the drapery, is unknown, but personal recollections, about which there has lately been much talk, are connected with the picture. Last summer, when I was making a visit at Martonvasar, the lord of the castle, Count Geza Brunswick, surprised me very much by showing me this picture, which he told me belonged originally to Beethoven himself, who gave it to the father of the count, Count Franz, who was bound to Beethoven by the closest friendship. The fact that the old count always took the picture with him when the family made the regular changes of residence between Martonvasar and Pesth, shows how highly he prized it. After knowing these particulars, one will read with increased interest the accounts of the relations between the two men given in Thayer's and other well known biographies.

For the accompanying engraving we are indebted to our worthy contemporary the *Illustrirte Zeitung*.

[From the Sun, New York.]

## THE RELATION OF MACHINERY TO COMMERCIAL AND INDUSTRIAL DEPRESSION.

The benefits derived from the use of machinery have thus far outnumbered the disadvantages, and there has been sufficient employment in most countries for the major part of the people; yet there have been serious industrial dislocations consequent upon the adoption of new processes by which the industrial and commercial interests of great populations have been revolutionized, and intense suffering brought to displaced artisans and laborers. A notable example of this is found in the effect of European machinery upon the hand loom industry of India, whereby millions of handicraftsmen were forced into the already congested ranks of agricultural labor. Thus, closing the present account, a balance may appear to the credit of machinery; but what of the future? Indeed, what of the present? And what part has machinery played in bringing about the industrial world's present unsatisfactory condition?

Under the old industrial regime, exchanges were slow and of small volume, nearly every country providing the food its people consumed, the greater part of the textiles worn, and the metals used. It was not until feudalism died and industrialism found a home in the free cities that man's inventive faculties were brought into constant use other than as an aid to the armed hand of the ruler. The decay of feudalism was coincident with the development of industrialism, with the birth of civic freedom, and with an enormous increase of mechanical aids to labor.

Estimating the power of steam, and exhibiting its beneficence, by showing the numbers of men and horses to which its applications are equivalent, has been, and still is, a favorite employment with those who ever prate of "the progress of the race and the march of improvement." Few think it worth their while to attempt to either measure the present, proximate, or ultimate effect of such tremendous forces upon individual and national welfare, and what must be the inevitable result if this "march of improvement" continues without a commensurate increase of the individual power to consume, on the part of the great mass of the populations. That mass is made up of wage earners and cultivators, and constitutes at least four-fifths, and probably nine-tenths, of the world's consumers of the products of manufacture. Nor do those optimists ever stop to inquire if such an increase of consumptive power is probable or even possible.

Fortunately for those living in the nineteenth century they came upon the stage at a time when a great part of earth's most productive areas, such as temperate North and South America, Australia, and a part of South Africa was being subdued; when new regions were affording ample scope for enterprise and homes, and employment for the immense swarms yearly leaving the European hive; when countries were being developed exceptionally productive of all the precious and useful metals, and, more important than all else, assuring, by their ability to grow a great surplus of food and fiber, the comfort of the new populations and those remaining in the ancestral lands. That is, conditions have been the most favorable possible for a great and wholly unexampled increase of agricultural, textile, and metalliferous production, and a rapid absorption of the products of manufacture by new communities lacking the capital and equipment necessary for the domestic production of the wares required. The demands of the new communities for manufactures have been supplemented by those of the inferior races who are concurrently subjected to the domination of western commerce, while the machine-made products of England, Holland, France, and Flanders displaced those of the domestic hand loom among the enormous populations of India and Asia generally.

Under conditions which have existed respecting undeveloped agricultural areas: the facility with which the emigrating myriads were able to found new homes; the creation of new markets in the younger communities; the extension of commerce among the inferior peoples; the coincident and consequent destruction of a very considerable part of the domestic industries of India and other Eastern countries; the creation of vast manufacturing, transportation, and agricultural equipments, and the ease with which an adequate supply of food and fiber has been secured by the cultivation of newly subdued areas of surpassing fertility—all these since the inventions of Watt, Whitney, Hargreaves, Arkwright, and Cartwright have made it possible to multiply the productive power of each labor unit employed in manufacture and related industries almost indefinitely, without effecting such industrial and commercial dislocations as to cause widespread suffering, except in India and lesser districts. But these conditions no longer obtaining, it becomes a very serious question how much further the progressive application of labor-saving devices can be carried without grave disturbance of both industrial and social conditions, unless there shall be a concurrent increase of individual power to consume commensurate with all increase, past and to come, of the unit power to produce. Hence the problem of the distant as well as the proximate future resolves itself into one of the possibility and probability of such an increase of the power to consume as will absorb not only all the commodities which an industrial equipment and labor force already much too great can turn out, but all that can result from further augmentation of each labor unit's productive power. This is the most serious problem that has ever confronted the human race, and is the most serious it can ever confront except the somewhat remote one of providing the food for a population that now increases four times as fast as does the food-bearing area.

This problem involves an inquiry as to the measure in which the unit power of production has increased this century.

Adam Smith died without a knowledge of the condensing steam engine, the cotton gin, or the electric telegraph. He had never seen a railway, steamship, or grain harvester, and knew, probably, little of the spinning jenny, power loom, or of one per cent. of the many thousands of labor-saving devices brought into use during the last one hundred years, that have certainly multiplied the unit power of production, in the sum of all manufactures, not less than fiftyfold and probably more than one hundredfold.

In cotton spinning, one man and two boys now produce as much yarn as did 1,100 spinners using the single-spindle hand wheel; and one operative employed in weaving turns out forty to fifty times as much cloth as did the hand loom weaver. It is manifest that there can never be an equivalent increase of the unit power to consume cotton goods.

In the case of woolen and other superior textiles, the increase of unit productive power has been less; yet, it has been far in excess of any possible increase of the unit power to consume. Moreover, in most textile manufactures the robust hand loom weaver has given place to the female and child, and this sends the male descendants of the hand loom operative to the recruiting office in increasing numbers.

Formerly lace making was a household industry of great importance in western and central Europe, but machine-made lace has displaced the greater part of the hand made; and while it is impossible closely to approximate the amount of labor thus displaced, it is very great, as has been the distress thereby brought to villager and peasant, whose meager incomes have been cut in twain, with much of their purchasing power destroyed. Lace is a luxury, and while cheapened production has extended its use, this extension bears but a slight proportion to the labor displaced.

Swiss watchmakers were able to turn out an average of forty watches a year. Each operative in an American factory turns out from 250 to 300 watches yearly, machinery displacing fully eighty per cent. of the labor. While the lessened cost of watches has greatly extended their use, such extension is far from being commensurate with the increase of each labor unit's productive power. When the whole population shall be fairly well supplied with an article so durable, and the cost of food shall absorb an increasing proportion of diminishing individual revenues, the power to consume watches will decline, and the displacement of labor will be severely felt in such communities as that of Switzerland. Even now, the power to produce is so excessive that prices are maintained only by combinations to restrict the number of watches made. With the multiple forms of woodworking machinery, the labor of one man now equals that of one hundred in the days of Adam Smith, except in the finest cabinet and carriage work. Similar reductions have been made in the labor involved in the production of articles made of both wood and metal, and in all such forms the lessened cost of production increases consumption in only small degree.

In the paper-making and leather industries the labor displaced by improved processes averages quite ninety-five per cent.

The amount of labor displaced by machinery in the boot and shoe trade is a fairly well kept trade secret, but the proportion is very great, although the retail price of the product falls but slowly; and the increase of unit consumption is so slight as to afford no compensation for the increase of the unit power of production. In the very nature of the case, there can be no great increase of the unit power to consume.

Telephones are machines which have displaced labor by the elimination of the messenger, but they enable no one to consume the product of labor except as a result of their construction and maintenance. This is a mere trifle.

On the other hand, while the telegraph may be called a machine, it appears to have added to, rather than diminished employment. This cannot be said of the general applications of electricity, which are daily displacing more and more labor, a notable example being the device for stamping letters automatically.

Railways have displaced the stage coach, the canal boat, the carter, and lake and river craft of every description; still it is questionable if their construction and equipment have not, till this time, added to the sum of employment; but for the most of the civilized peoples the work of railway construction and equipment has largely been accomplished, and yet they may be looked upon as wholly beneficent, as aiding the laborer by increasing his mobility and distributing his products, which otherwise, in some cases, would decay at the place of production. In fact, railways and telegraphs differ radically from productive machinery, although they so greatly facilitate production by speedy communication and transport and by bringing material with regularity to the place of conversion. Yet the sum of labor now employed in transporting by rail a given quantity of commodities is not more than half—if more than one-third—of what it was thirty years since, and the power of the labor unit to transport increases yearly.

A most notable instance of the increase of unit productive power is found in the latest forms of the printing press, which turn out hundreds and probably thousands of times as many square feet of printed matter for each pressman employed as did the hand press of Franklin's day. The type-setting machine is sending the compositor to the rear with great celerity, as other machines are sending to the rear the makers of the cheaper books, while diminishing the labor required on the higher priced. Unlike wheat, shoes, and such indispensables, the lessened cost of printed matter increases the unit power to consume, but even here such increase is relatively small as compared with an enormous increase of the unit power to produce.

It is impossible to even approximate the increase of unit power of production in such employments as quarrying, mining, and the carriage of sea-borne commerce, by reason of the application of labor-saving devices and the substitution of large steam craft for the smaller sailing vessels. The steam engine, electric lighting of mines, the diamond drill, compressed air, coal and rock cutting machines, and an innumerable array of other devices have lessened in an extraordinary degree the labor force required to accomplish a given end; just as the enlargement of the water craft and the railway vehicle and the substitution of steam for sails have increased immensely the unit power to move commodities and people by land, lake, river, and ocean. This displacement of labor, increasing now at a progressive rate, has been accompanied by not the least increase of the unit power of the labor employed to consume the products of other labor, except in the measure of the reduction in the price of such products.

In the conversion of ore and metals into useful forms, machinery and labor-saving processes have effected nearly as great an increase of the labor unit's productive power as in the case of textiles, although the ratio of increase varies with every product. Still, each workman now employed in such industries has quite as great an average productive power as had 100 in the days of Adam Smith.

For each operative employed, the Burden horseshoe machine turns out as many shoes as 500 blacksmiths can make with anvil and hammer; and a single nail-making machine turns out for each labor unit employed, more nails than 1,000 men could shape by hand.

Although in agriculture the displacement of labor by machinery has been relatively much less than in other forms of production, even in the United States, Canada, Australasia, and Great Britain, where alone it has come into general use, yet so great has been its effect that Mulhall estimates the productive power of one unit of American agricultural labor as equal to that of nine in Europe. If the small size of most European holdings did not preclude the use of machinery, there can be no doubt that the displacement of agricultural labor upon the Continent would be nearly as great as in the United States. In America, notably in the Northern and Western States, the use of farm machinery has been stimulated by scarcity of labor in recent periods, and by the size of farms. Large farms render profitable the use of appliances that the occupier of the small holding can afford neither to buy nor to operate; and this, again, has a very pronounced tendency to increase the size of farms.

Probably the use of labor-saving devices and the cessation in large part of forest removal, have, since 1850, quintupled the productive power of each labor unit employed upon American farms; but it is certain that this increase of the unit power to produce has, so far as the whole food-consuming populations of the temperate zones are concerned, been offset by but slight increase of the unit's power to consume farm products; and the excessive production of food by reason of the cultivation of too many acres, facilitated and made possible in some degree by machinery, has greatly reduced the power of the labor units employed on the farms in the United States, as elsewhere, to buy of the products of the fabricants' labor. So far as food staples are concerned, machinery, from the very nature of things, exerts a most disastrous effect upon the agricultural wage worker by lessening his employment without the possibility of compensation for the community by increase of unit consumption of farm products. Machinery has driven the farm laborer out of the field and to the crowded railway, mine, and factory, where he competes with others for employment rapidly growing relatively less.

Had it been possible to reduce to the American ratio the labor required to cultivate a given number of acres in Europe, India, China, and Japan, and had the displaced workers been forced into the ranks of those fabricating and distributing wares, as they necessarily must have been, what a frightful condition would now be that of the wage earners of all lands! Yet this would have been but a further exhibition of "the progress of the race and the march of improvement." When we contemplate the possibility of such conditions, we can heartily commend the wisdom of the Chinese ruler who, legend hath it, caused all the farm machinery in the empire to be destroyed and its reconstruction prohibited upon pain of death, because it robbed the people of the employment necessary to their very existence.

Were it possible to substitute machinery for hand labor in India, in the same ratio to cultivated acres as in the United States, nearly or quite half of a population of 300,000,000 would thereby be deprived of the work and earnings absolutely necessary to their existence, as there is no other possible employment.

The industrial equipment of the western nations is quite sufficient to supply the whole world's population with much more of nearly every product of manufacture than can possibly be consumed. There are great and rapidly increasing additions to the industrial equipment of India, China, Japan, and even of such countries as Afghanistan, by the adoption of western processes and the best machinery of European make. The cultivator's power to purchase has been greatly diminished, the world over, by reason of excessive additions to the cultivated acreage, made mostly in the United States since 1870. The revenues and expenditures of artisan and laborer everywhere are steadily decreasing because of lack of work, due to the inability

of cultivators to buy as largely as formerly of the product of others, and by reason of the enormously increased power of each industrial unit to produce. Vast masses of labor are partially idle, and retain but little purchasing power, which have heretofore been engaged in the construction of steamships, railways, and existing industrial equipments. All this being so, it would be wholly unaccountable had not activity and prosperity given place to stagnation, vanishing profits, lower wages, idleness, and distress, as well as to a constantly diminishing ability to consume wares for the production of which the available labor is as excessive as the equipment.

Excessive power to fabricate has destroyed much of the power to consume the products of manufacture; and the low price of food and fiber, due only to an excess of cultivated acres and the resulting excess of agricultural production, intensifies this inability to consume, by diminishing the landowner's and the cultivator's power to command the products of others.

In short the commercial and industrial world suffers from such an excess of all forms of productive power as greatly to lessen the consuming power of any given population for everything except indispensable articles of food. And this is wholly due to an increase of the unit power to produce fabrics; that is machinery alone has produced this condition.

Only in the direction of soil production is there any great and, at the same time, lasting improvement probable or even possible; and here only because of man's inability to multiply, with all the aids at his command, the acres which are actually or potentially productive, and which are now so nearly occupied as to not much longer make it possible to grow a plethora of grain, meat, and cotton.

On the other hand, the products of manufacture are easily capable of infini e multiplication, as, given the food, is man. And their production in excess of the power to consume is assured by existing conditions which indicate an indefinite if not an unending period of falling wages: lower prices for all products, other than those of the soil, where not maintained by combinations to restrict production; a ratio of profits declining as do prices, and a general if gradual lowering of the standard of living.

Aside from the passing effects of an acreage long excessive, but now little if any in excess of current needs, these results, deplorable as they are, follow inevitably from the enormous increase of each labor unit's power to produce. Such increase is directly traceable to the adoption of labor-saving devices that were but mere possibilities in the days of Adam Smith.

## THE MAGIC TAMBOURINE.

THE prestidigitator, taking a tambourine formed of a sheet of white paper and two silver hoops, bursts the paper with his fist, and pulls out two silk handkerchiefs and a lot of serpentines. Then, gathering up the paper, he causes a turtle dove to appear.

This trick is performed as follows. Take a circle of telegraph tape (Fig. 1), place upon it two small silk handkerchiefs folded square, and cover the whole with a disk of white paper of a little wider diameter than that of the ring of tape. Turn down the edges of the paper (Fig. 2), fasten them with paste to the sides of the tape, and place the whole in the inside of your vest, to the left, the white paper against the shirt. In the other side of the vest place a turtle dove.

Having manufactured your tambourine, hold it against your breast, and, with the thumb and forefinger of your right hand hidden by it, seize the roll of tape and introduce it into the interior of the tambourine in making the whole slide from left to right.

Now burst the head of the tambourine, take out the two handkerchiefs (Fig. 4), and pull upon the telegraph tape, and unwind it up to the very end (Fig. 5). Then lay down the tambourine and allow the paper to fall.

Stooping over, gather up the paper in a bunch (Fig. 6), in front of your breast, and profit by this moment to grasp the turtle dove with the left hand and introduce it into the interior. Lay the whole upon a stand, and, separating the strips of paper, take out the dove (Fig. 7).—*Le Magasin Pittoresque.*

## SLEDGE RACING IN HOLLAND.

OF the numerous forms of ice sport in Holland, none are more interesting than the races in pricking-sledges. These take place principally in out-of-the-way districts, where the peasants still dress in their national costumes. As a rule there is not much color in Dutch native dresses, but those worn in some parts of Friesland are more picturesque than in other places, and especially is this the case at the old town of Hindeloup. On the occasion of a skating meeting the inhabitants for miles round flock into the town, and the greatest excitement prevails. There are all sorts of contests, skating for both men and women, sledging of the ordinary kind, trotting for horses, and then races in these pricking-sledges. They are made of wood, often beautifully carved or gayly painted, and the competitors sit in them and propel themselves along with short sticks with iron points, so as to get a firm grip of the ice. The courses are of only a short length, but the interest caused is very great, and as it requires a considerable amount of skill to steer the sledge in a direct line, collisions are frequent, and much hilarity caused by them and the erratic movements of some of the competitors. The proceedings are altogether of a most unique character, and no visitor to Holland in the winter should fail to attend such a meeting, if it is at all possible to do so.—*The Graphic, London.*

A SLEDGE RACE AT HINDELOUP, IN HOLLAND.

## JAPANESE HOT SPRINGS.

BEING out on the coast of Corea and Japan, looking for things curious, I secured from the natives intelligence of a remarkable place in the remote interior of an island belonging to Japan called Kieushu. The place is commonly called "Seven Hells," and, on account of its inaccessibility and remoteness, has seldom been visited by Americans or so much as referred to in print. I determined to visit this Japanese inferno, and having everything arranged I set out with provisions for a two weeks' travel. The first few days were spent in a small Japanese steamer crossing three or four inland seas, and winding around at least a thousand different islands to get in reach of the mainland that would lead me to the end of my journey. It may appear to be an exaggeration to speak of so many islands and seas, but when it is remembered that Japan alone has 4,000 islands and at least 100 different seas, it will not appear strange that I passed 1,000 islands in search of the one on which is the phenomenon.

When I had got as far as I could go by water, there was nothing left for me but to try the crude mode of travel of the islanders for 100 miles or more. I hired a jinriksha and two coolies to pull me, and at once proceeded. A whole day and night were spent in this funny vehicle, until I came at last to mountains so steep that it was impossible for me to ride further. Then another change in my mode of travel was made. I hired a coolie and pack horse to carry my baggage, while "I took my foot in my hand and walked" for twenty miles over that rugged mountain.

Once over the mountains I was almost in sight of the "Seven Hells." An arm of another sea lashed up in a narrow neck. On every side stood gigantic mountains capped with snow, while below lay the beautiful valley. It seemed as if I might be entering Paradise. I walked a little further, and in a moment the earth resounded as if a thousand cannons were exploded beneath me. I had reached the "Seven Hells," and all that had been told me of the place was fully demonstrated.

Just a few yards from where I stood was the "Boiling Sea." A great smoke and steam arose like a cloud from the water, and upon examination I found that the sea of water was boiling and bubbling like a pot over a stove. The water was scalding hot, and would cook an egg in two minutes. This boiling sea is considered sacred by the natives, and the government had at one time to erect a fence around it to keep the people from plunging in.

From the Boiling Sea a continual stream of hot water runs down through a village of about 300 people, who are the most peculiar human beings outside of China. In the center of the village is a big round bath of hot water from the sea. In this bath from ten to twenty-five are constantly to be seen bathing. There are no screens or coverings, but men, women, and children all bathe together in Adamic simplicity. I saw at one time nine women and ten men in the bath.

About fifty steps away from this place is a "sweat bath," dedicated to one of their gods. An open shelter is built in the streets over a cavern in the earth which they say Budona built for them. The excavation has a door to it similar to an old-fashioned sweet potato house that Southerners build to keep their potatoes from freezing in the winter. The door is about three feet square, and there is no way for either a person or the steam to escape except by this door. In the front were priests selling tickets for half a cent each, and six persons were admitted to the sweat bath at once. Just over the entrance stands an image of Buddha, with rice cakes, flowers, and incense offerings. The people worshiped as they went in, while an old priest stood by telling the people that whosoever bathed in faith should be cured of all maladies. The lame and crippled flocked around and listened with eagerness. The priest said that Buddha sent down his angel, who met an ancient priest and told him that he would write the name of Buddha on a stone and cover it with the earth and cause the mountains to gush out with hot water and flow over the name of Buddha for the healing of all diseased believers. "This," said the priest "is the place prepared by the great gods, and if you would be

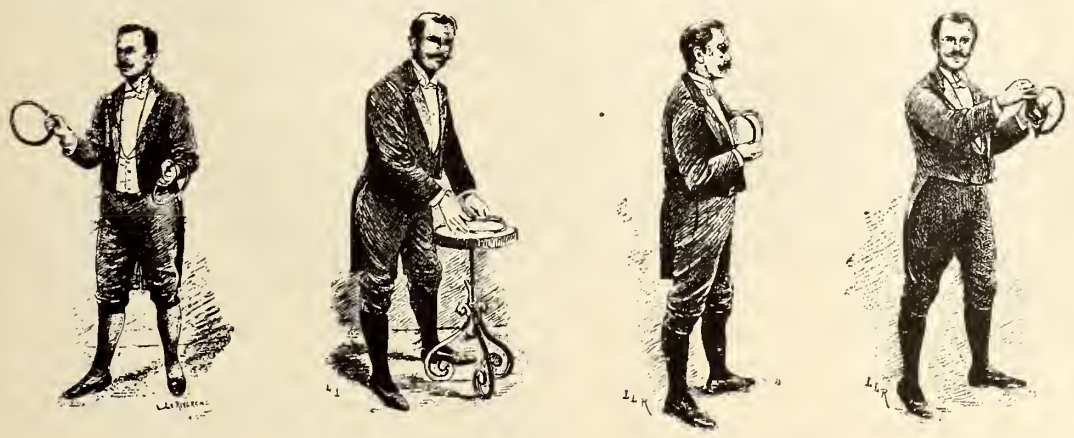


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Fig. 5. Fig. 6. Fig. 7.

THE MAGIC TAMBOURINE.

healed enter in and bathe." It was amazing to notice the deluded men and women, in companies of six, go into the bath and stay until almost dead from suffocation, and come out dripping with perspiration and covered with straw. It seems that a stream from the Boiling Sea runs under the excavation, and inside is thrown a lot of straw on which these men and women spread themselves and stay until they fairly roast themselves alive. From this place they go to a hot shower bath, which consists of several large bamboo poles placed in a waterfall from the hot sea, which fell about ten feet upon the bodies of the saints just from the sweat bath. From the shower bath they go to the fountain bath, where the course is completed. The entire process often takes several hours and is gone through without clothing or towels of any kind. This keeps the streets alive with men and women walking here and there as naked as they were born into the world.

Another peculiarity of this strange people is the way they cook and eat. Everything they do has some religious superstition connected with it, and their cooking and eating are not an exception. I am safe in saying that no people on earth cook like the people who live at the "Seven Hells" on the island of Kieushu, in the marvelous little nation of Japan. They have arranged to run the water from the Boiling Sea in small streams, about a foot under the surface of the earth, right in front of every man's door. Over these streams are mud ovens built like a pot, with a lid over some of them. In their ovens the people place whatever they want to cook, and the steam from the hot water does the work. This is certainly better than natural gas. Many of the people, and in fact most of them, merely dig a hole down to the hot steam, place some straw over the water, and put their potatoes, etc., in and cover them up for a while until they are ready to eat. I saw many people cooking in this way.

## REFRIGERATING APPARATUS.*

By Prof. Carl Linde, of Munich.

The results of recent investigations on low temperatures have never before been brought under public notice in so complete and comprehensible a manner as has been done by Professor Dewar in his lectures on the liquefaction of gases, investigations commenced by Faraday and continued by a number of physicists, but in no case with greater success than by Professor Dewar.

I will select from those lectures only the description of a method by which it is possible to liquefy the substances called up to recent times permanent gases, especially the constituent parts of atmospheric air (oxygen and nitrogen). If we take a drum filled with liquid carbonic acid (as obtainable in commerce) and allow the carbonic acid to pass into a vessel (Fig. 1) in

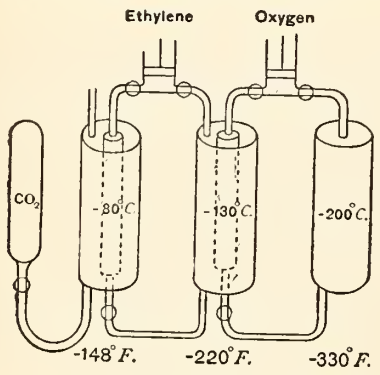



Fig. 1.

which atmospheric pressure is maintained, the carbonic acid will boil at —80° C. (—112° F.) If we now compress ethylene vapors by means of a compression pump into a second vessel placed inside the first receptacle, it will liquefy, and, on allowing the liquid ethylene to enter a third vessel, inside which atmospheric pressure is maintained, the boiling point of the liquid will be about —100° C. (—141° F.) If, however, the pressure were to be reduced, then the boiling point of the liquid could be lowered to —140° C. (—220° F.) If, further, by means of a second compressing pump, oxygen be compressed into a closed vessel placed within the ethylene vessel, liquid oxygen is obtained, boiling under atmospheric pressure at — 180° C. (—290° F.), and by reducing this pressure the last named temperature can be lowered to —200° C. (—328° F.), at which point atmospheric air will condense on the surfaces of the vessel, even when not compressed.

Here, then, is a way opened for technical enterprise, enabling us, by methods now fully available, to produce and maintain temperatures below —200° C. (—328° F.), and not far distant from absolute zero, which we know physical science to place at —273° C.

The uses to which industry may put this discovery cannot as yet be certainly defined. The lowest temperature hitherto employed for industrial purposes is —110° C. (—166° F.), a temperature utilized to distill in vacuo the subtilest constituents of certain organic substances, and to produce them in this manner of a purity hitherto unknown

Excepting these isolated applications, the temperatures, for the creation of which the industry of to-day employs refrigerating machines, do not lie greatly below the freezing point of water, and in at least 95 per cent. of all applied cases, there is a demand only for temperatures above zero Fahrenheit. But inside this narrow temperature range, refrigerating machinery has found within the last two decades an application so extensive and manifold that it would take an entire evening to enumerate and describe them briefly. Probably no other branch of mechanical industry, with the exception of electricity, has developed so rapidly during that time. Our industries may avail themselves of a number of machines and apparatus which are capable of creating and maintaining in an entirely reliable manner the desired temperatures. Those who require refrigeration need not to-day consider the question of the machine system supplying the cold in a reliable and regular manner, but they will seek to find the machine which will accomplish this in the most economical way; that is to say, the machine which will produce a given amount of cold with the least expenditure of work (or fuel) and of water.

I now propose to make a comparative review of the methods and the economical value of the working processes as they are performed by machines and apparatus chiefly in use at the present day.

The first attempts to construct such machines and apparatus were made with reference to certain isolated physical phenomena, and efforts were directed toward the utilization of these without any explanation being available as to the relation between the production of cold and the requisite expenditure of heat or mechanical work. It was only subsequent to the development of the mechanical theory of heat, and the application of its laws to the contemplation of the caloric processes in such machines, that inquiries could be made with success as to this connection between production and consumption. The following questions could then be put:

1. What efficiency (relation between production and consumption) is really obtainable?
2. What is the working process permitting the attainment of such results?
3. What position do the existing refrigerating machines hold with regard to the foregoing points?

Here we have to start with the consideration that the production of cold is a process by means of which heat is abstracted at a temperature below that of our surroundings, and, seeing that its annihilation is impossible, according to the principle of the conservation of energy, raised to such a temperature level that it can be transferred to surrounding parts (for instance, to the atmosphere or to water, briefly termed further on, "cooling water"). We may compare such a process to the action of a pumping engine having to keep the water in a shaft at a certain level by raising all inflowing water to a height from which it may flow away. (Fig. 2.)

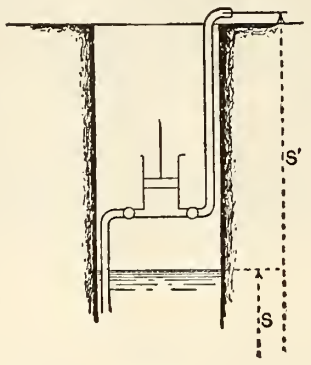



Fig. 2.

The raising of heat from a lower to a higher temperature (and it is herein that the action of a refrigerating machine consists) can, like the lifting of water, be effected only by the expenditure of a certain quantity of mechanical work. Concerning the amount of this work, we are taught by thermo-dynamics as follows:

If T be the temperature at which the heat is to be abstracted, and its quantity, H, heat units, and if T' be the temperature at which the heat can be transferred to the cooling water, then there will, for this purpose, be required a quantity of work, W, determined by the first law of thermo-dynamics by the relation—

$$A\,W = H' - H \qquad (1)$$

Herein A denotes the thermal equivalent of work and H' the heat discharged at the temperature, T'. The foregoing relation expresses, therefore, that the discharged heat, H', is equal to the abstracted heat, H, plus the equivalent of the mechanical work expended, seeing that this latter, imparted from outside, cannot disappear, but must be transformed into another form of energy, *i. e.*, in this instance, heat.

Assuming that the heat, H, be abstracted exclusively at the absolute temperature, T, and that H' be rejected exclusively at the absolute temperature, T', the second thermo-dynamic law expresses that the heat quantities, H and H', are proportional to the temperatures, T and T', thus:

$$\frac{H}{T} = \frac{H'}{T'} \qquad (2)$$

or by inserting the value of H' into the relation (1)—

$$A\,W = \frac{H}{T}(T' - T) \qquad (3)$$

The last formula expresses that, for the purpose of abstracting the quantity of heat, H, at T degrees (or in order to produce H heat units of cold) and raising it to the level, T', a certain number of work units, W, are requisite, if working with a perfect engine without any losses whatever.

I now explain this connection graphically. If in

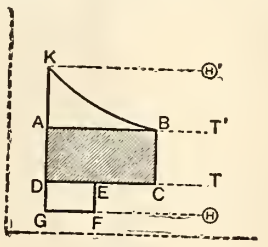



Fig. 3.

Fig. 3 the absolute temperatures are plotted as ordinates, and the values of $\frac{H}{T}$ and $\frac{H'}{T'}$ as abscissæ, then the equivalent of the work will be represented by the rectangle, A B C D, the length of which is $\frac{H}{T} = \frac{H'}{T'}$ and the height T' — T. For a given temperature, T, the minimum work corresponding to the production of a certain quantity of cold, H, is directly proportional to the difference of temperature, T' — T.

After just having compared the process of producing cold with lifting a weight of water, we now find a complete analogy to exist for the relation of the terms expressed by work. Referring to Fig. 2, we find the theoretical work for pumping to be:

$$W = G\,(S' - S),$$

G denoting the weight of water lifted. We recognize a complete identity, if G be put equal to $\frac{H}{T'}$, and in consequence of this analogy the term $\frac{H}{T}$ (designated in physical science as "entrophy") has been called "heat weight." In passing, I may point out that seemingly a difference does exist, because the heat weight $\frac{H}{T}$ of a certain heat quantity varies with the temperature, T, while G is considered as a constant value. But if we consider that $G = m \times g$, and that $g$ (the acceleration by gravity) increases as the mass, $m$, approaches its center of attraction, that, consequently, also G is really variable, and that we are accustomed to consider G as constant only because the values of S' — S, with which we have to do, are relatively very small, as compared with the distance to the center of attraction, that, consequently, also G is really variable, and that we are accustomed to consider G as constant only because the values of S'—S, with which we have to do, are relatively very small, as compared with the distance to the center of attraction, then we find, indeed, a complete analogy, provided we place the absolute zero and the center of attraction side by side. In our caloric processes, however, the difference, T' — T, is by no means infinitely small in comparison with T, and thus the latter must be taken into account.

By keeping in view the analogy between the performances of our caloric engines and those lifting weights, it is possible to demonstrate the working process of each single machine in a simple and intelligible manner, and to obtain a correct representation of the nature and value of these processes, even without mathematical deductions, which render to many the study of thermo-dynamic problems a matter of difficulty.

The consideration of the working process of the most important existing refrigerating machines has been selected by me as the special subject of my present paper. Let us consider again more closely the equation—

$$A\,W = \frac{H}{T}(T' - T).$$

It holds good, on the assumption that the abstraction of the entire heat quantity, H, be performed exclusively at the temperature, T, and that the corresponding heat quantity, H', be rejected exclusively at the temperature, T'. In the event of part of the heat being abstracted, not at T, but at a temperature higher or lower; if, for instance, only the part, E C (Fig. 3), of the heat weight be abstracted at T, while the heat weight, F G, be abstracted at $\vartheta$, then the work to be expended would be represented by the area, A B C E G F; or if the rejection of heat took place, not at the constant temperature, T', but a rising temperature corresponding to the line, B K, then the increase of work to be expended will be indicated by the area, B K A.

We perceive that a consideration of the formula $A\,W = \frac{H}{T}(T' - T)$ permits of an immediate answer being given to the questions raised.

1. It conveys to us the amount of theoretical work requisite for the abstraction of a certain amount of heat at a given low temperature, T, and for its rejection at a given higher temperature, T'; in other words, how many thermal units of cold at certain conditions of temperature can be produced per working unit, or, say, per horse power.

2. It teaches us that the working process enabling us to attain this most favorable efficiency must be conducted in such a manner that at no single point heat is abstracted at lower temperatures than those strictly determined by the given problem, and that the heat must not be lifted any higher than is absolutely necessary for its rejection to the cooling water. A process satisfying these demands is termed a perfect process.

I now, on the basis of the preceding data, pass on to the investigation of the third question: How do the existing refrigerating machines correspond to the results theoretically obtainable?

The classification of refrigerating machines into three groups is well known, namely, those in which the refrigeration is based upon the *expansion of atmospheric air;* and those basing the production of cold upon the evaporation of a volatile liquid, the return to liquid state being effected either by *compression* or *absorption*

Fig. 4 represents the cold air machine as usually now employed, and we will assume that the freezing chamber, R, has to be maintained at the temperature, T. The compressor draws in air (wholly or partly out of the chamber, R) and compresses it to about three or four atmospheres, the work of compression being simultaneously converted into heat and the air being heated to the temperature, $\vartheta'$. By means of direct or indirect contact with cooling water, this air is reduced, as near as possible, to the temperature, T', of the cooling water, and is then admitted into an expansion cylinder, there expanding to atmospheric pressure; hereby the equivalent of the work expended upon the expansion piston is abstracted from the air and its temperature is accordingly lowered to a certain temperature, $\vartheta$. The air enters the freezing chamber, R, at

* A lecture delivered before the Society of Arts, London, March 7, 1894. —*From the Journal.*

this latter temperature, and abstracts heat from the air in this chamber by being heated from $\theta$ to T.

How far does this performance correspond to the conditions of the perfect process? The problem set to the machine amounts simply to maintain the room, R, at the temperature, T, *i. e.*, to abstract all heat developed

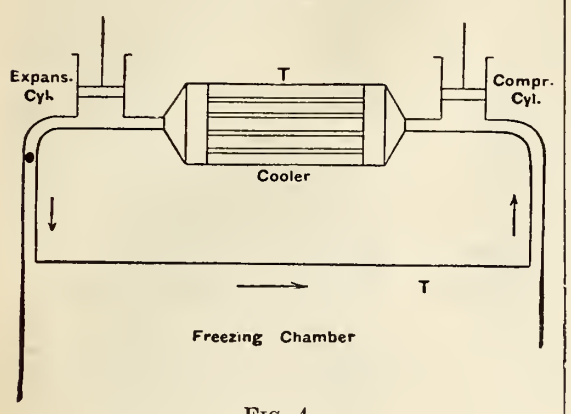



FIG. 4.

in this chamber or entering it from without, at the temperature, T. This is here accomplished by introducing the air at a far lower temperature, $\theta$, and heating it to T. We recognize at once that the work, A B C D (Fig. 5), theoretically necessary for lifting the heat weight has been increased by the area, C D E, because the heat weight must be lifted, not from the constant level, T, but from a depth varying between $\theta$ and T. But let us continue. The compressor aspirates air of the temperature, T, and compresses the same with a simultaneous rise of its temperature, If the compression takes place, as it is in principle, adiabatically—that is to say, without the addition or abstraction of heat—then the rise in temperature must, at least, be equal to T—$\theta$, because, according to formula 1, there must be rejected between $\theta'$ and T' the same quantity

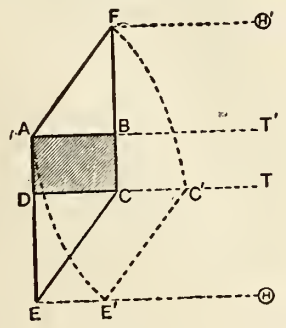



FIG. 5.

of heat which has been abstracted between $\theta$ to T, plus the equivalent of the expended mechanical work. Thus we find present, also, in an upward direction, an excess of the theoretically requisite work determined by the area, A B F. The circumstances are the same as if we had to lift a weight from a height, T, to a height, T', and effected this in such a manner that we allow the pit cage to descend to $\theta$, then fill the load into it while raising it from $\theta$ to T, and as it the cage were then lifted to $\theta'$, and afterward let down to T', discharging the load during the last movement. We have not here to deal with small heights, for, unless the cylinder dimensions, and with them the external losses, are allowed to attain gigantic proportions, the temperature, $\theta$, of the air admitted into the chamber at E must be far below that of the air temperature, T, in R. If we put the latter at 20° F. and assume the incoming air to be at 75° F., then each cubic foot of air will abstract about two thermal units, while at the same temperature the formation of one cubic foot of ammonia vapor would abstract about 83 heat units. If the cooling water temperature be 65° F., and if in consequence the temperature lift required from the machine be 45° F., then E D will be twice as great as A D, and we observe that in this instance the area, A F C E, is about three times larger than the minimum of work theoretically required (A B C D). In addition we must consider that the reduction of temperature during expansion—in consequence of various losses (especially through exchange of heat through the cylinder walls, through leakages, through the presence of water, etc.)—is far smaller than it should be according to the pressures. This produces the same result as if the expansion were performed, not adiabatically, but under a simultaneous imparting of heat to air, expanding from A to E', and consequently the requisite work becomes actually much greater, as represented by the area, A F C' E'. If we add the further increase of work due to the exterior resistance of the relatively very large working cylinders, it will be clear why the best executed cold air machines possess an expenditure of work surpassing at least tenfold the minimum consumption of power found from the relation—

$$A\ W = \frac{H}{T}(T'-T)$$

Leaving the cold air machines, I now turn to the second class of refrigerators, working on the principle of evaporation and compression of a volatile liquid.

The annexed figure (Fig. 6) represents the working principle of such a machine; they have been termed "cold steam engines" by Zeuner, as they represent simply the reversal of a steam engine. The liquid (sulphurous dioxide, ammonia, carbonic acid, etc.) enters the coils of the refrigerator, evaporates in them, and thereby abstracts the heat necessary for evaporation (latent heat) from the surrounding liquid (brine, for instance), at the temperature, T.

The vapors thus generated are aspirated by the compressor and forced into the condenser at a pressure corresponding to the temperature, T', at which the transfer of the latent heat to the cooling water is rendered possible. The condensed liquid returns by the regulating valve into the refrigerator. Let us now ask to what extent does this process satisfy the conditions which we have found to constitute the perfect process.

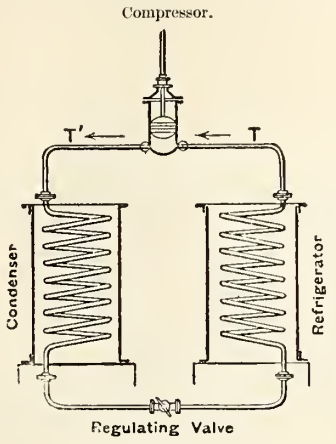



FIG. 6.

The abstraction of heat is performed in the refrigerator at the temperature, T (Fig. 7). The compressor then lifts the heat without any addition or removal of heat (*i. e.*, adiabatically) to the temperature level, T', whereupon it is transferred to the cooling water at this latter temperature. Thus far the process corresponds to the conditions specified. As regards the return to the lower temperature, T, this should be performed without addition or rejection of heat (*i. e.*, under adiabatic expansion), but as the liquid streams under the influence of the pressure $p'$ through the regulating valve into the refrigerator standing under the pressure, $p$, its liquid heat is reduced from $q'$ H U to $q$ H U and this heat $(q'-q)$ abstracted at decreasing temperature (A E) is employed to evaporate part of the liquid before its entrance into the refrigerator. There will be thus imparted to the refrigerator the liquid heat,

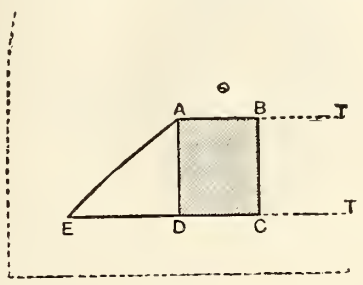



FIG. 7.

$q'-q$, at the temperature, T, corresponding to the refrigerator pressure, $p$ (E D).

I am neglecting here, as being comparatively small, the equivalent for the work corresponding to the transit of the liquid from the pressure, $p'$, to that of $p$, which strictly should be added. Hence we have, as a fact, that the weight unit of volatile liquid flowing from the condenser to the refrigerator enters the latter as a mixture of liquid and vapor, the vapor part being

$$\frac{q'-q}{r},$$

if $r$ denotes the latent heat of the weight unit at the temperature, T.

The greater, therefore, $q'-q$ as compared with $r$, the greater will be that portion of the aspirated and compressed vapors which arrives at the refrigerator already in the state of vapor, and the smaller will become that part of the aspirated vapors which has been formed in the refrigerator, and has abstracted heat from the surrounding brine. Only the removal of the last named heat can be regarded as useful refrigeration, but the work of compression has to be performed not only upon the vapors usefully developed in the refrigerator, but also upon the vapors represented by

$$\frac{q'-q}{r},$$

the formation of which does not contribute to useful refrigeration. Consequently the total requisite work of compression is increased closely in proportion to the ratio,

$$\frac{q'-q}{r}$$

While for the perfect process the nature of the volatile liquid is entirely immaterial, we find for the process, as actually carried out, the efficiency to be dependent upon the ratio between liquid heat and latent heat, and in this respect the various liquids in use behave very differently. I should now like to deal with this more fully.

If we intend to transform any liquid possessing the temperature zero into saturated vapor of the temperature, $t$, we have to convey to the weight unit of liquid an amount of heat termed "total heat," and composed first of the liquid heat, $q$, that is, the heat necessary to raise the temperature of the weight unit from zero to $t^0$, and, secondly, of the latent heat, $r$, that is, the heat necessary to convert the weight unit of liquid of the temperature, $t$, into saturated vapor of the temperature, $t$, under the pressure corresponding to this temperature. If we plot in a diagram (Fig. 8) the temperatures as ordinates, and as abscissæ, both the liquid heats ($q$) and the total heats ($\lambda=q+r$), we obtain curves leaning away continuously from the ordinate line in their upward course, because both heats increase with increasing temperatures.

The accompanying figure represents these values for the two most important volatile liquids, ammonia and carbonic acid; and we recognize at first sight that for ammonia the values of $r$ are relatively far greater to those of $q$ than for carbonic acid. We even notice the fact that for a certain temperature, $r$ is reduced to nought, such temperatures constituting the so-called "critical temperature."

The following considerations will show that such must be the case: If in a diagram the temperatures be plotted as ordinates, and the specific volumes (the volumes of the weight unit) of the liquid and of the

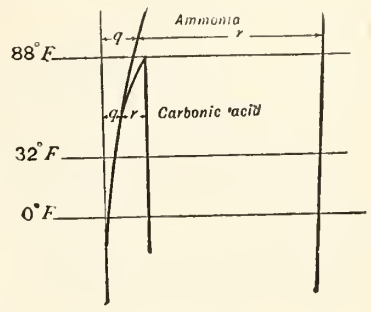



FIG. 8.

saturated vapor as abscissæ; $a\ b$ will represent the curve relating to the liquid (the volumes of the liquid *increase* with the temperature); and $c\ b$ will denote that for the saturated vapors (the specific volumes of these *decrease* with increasing temperature). Thus there must exist a temperature at which the volumes of the liquid and of the saturated vapors coincide, *i. e.*, at which no change of volume is involved for the transition from the liquid state to that of saturated vapor, and at which, consequently, the requisite demand for latent heat is nought.

It follows that the refrigerating efficiency of a cooling machine, in which the volatile liquid is conducted to the regulating valve at the critical temperature, is reduced to nothing, as long as saturated vapors only are withdrawn, because in this case the liquid heat, $q'-q$, equals the latent heat, $r$. But if the vapors are brought to the refrigerator with a temperature of $\theta$ (Fig. 9) lying far below that of the brine, T, then they

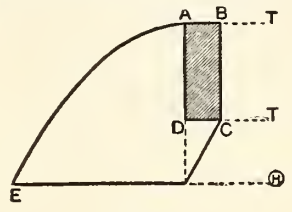



FIG. 9.

may be enabled, by assuming the superheated state, to abstract from the brine a certain (specific) heat, and to maintain some amount of refrigeration. Fig. 8 represents the work theoretically required by the area, A B C D, while the area, A B C E F, expresses approximately the actual expenditure of cost, if all losses from other sources be neglected.

It will be clearly recognized from what has been said that it is disadvantageous to employ in a compression machine a volatile liquid possessing its critical point within or close to the temperature range within which the working process is performed, because in such a case the liquid heat, $q'-q$, is relatively great in comparison to $r$. If, on the contrary, a volatile liquid be selected, for which the ratio between these two heat quantities is small, for instance ammonia, then the process, as performed in a compression machine, approaches the theoretically perfect performance so nearly that, according to incontestable proof, up to two-thirds of the cold determined by the relation $\frac{H}{A\ W} = \frac{T}{T'-T}$ can actually be obtained under ordinary conditions of working.

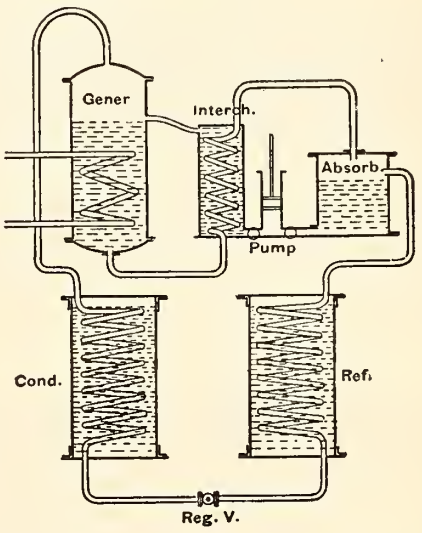



FIG. 10.

The third group of refrigerating machines—absorption machines—have a condenser, a regulating valve, and a refrigerator, just as in the case of the compression machines; but the compressor is substituted by a combination of other elements, whose functions, I believe, are well known. The ammonia vapors are, in the first place, absorbed by a weak solution of ammonia in water, which, after having been saturated, is pumped into the generator, exchanging on its way its temperature with that of the weak solution coming from the generator. The temperature in the generator is then raised by means of heating (mostly done by steam) to such a degree that the ammonia is driven out from its solution, and that the corresponding pressure of the developed vapors is sufficient to force them into the condenser, where they are liquefied at the temperature, T'.

The working process is, therefore, identical with that of the compression machine in the following

points: At the constant temperature, T', in the condenser, the latent heat, $r'$, is rejected (A B in Fig. 7), then the liquid heat, $q'-q$, is given up at temperatures decreasing from T' to T (A E in Fig. 7). Entering the refrigerator, the ammonia abstracts from the brine the latent heat, $r$, minus the liquid heat just referred to. In this way the usetul cold, $r-(q'-q)$, is produced just as in the compression machine.

The return from the temperature, T, to the temperature, T', is, however, not affected by direct compression. The vapors are not raised to the necessary pressure for liquefaction by the action of a piston, but in an indirect way by means of absorption and distillation. The same mechanical work is to be done in either case, only the nature of the performance is different. Instead of compression by a piston the volume $\sigma$ of the liquid ammonia is transformed in the generator to the volume, $v$, by heating under the pressure, $p'$, necessary for liquefaction, thereby the mechanical work, $p'(v-\sigma)$, is performed. This work is equal to that to be done in the compression cylinder.

The fact that in the absorption machine the work is produced by the direct application of heat makes the comparison with the compression machine somewhat difficult. The refrigerating machine and the motor may be taken as being combined in the absorption machine For comparison with the compression machine the latter must be supposed to be driven by a heat motor, say a steam engine, and both, *i e.*, the heat motor and the compressor, are to be considered as one unit side by side with the absorption machine. The question is now —How many heat units must be expended for the production of one therual unit of cold ?

For the compression machine we had :

$$\frac{A\,W}{H} = \frac{T'-T}{T}$$

It is well known that in order to produce the work, W, in a steam engine a far greater amount of heat has to be expended than A W, because only one part of the expended heat can be transformed in mechanical work. If, for instance, we have to deal with a steam engine with a consumption of 14 lb. of steam per horse power hour, the proportion of A W to the actual consumption of heat, $H_s$, will be about 1 : 6·33, and we have for the expenditure of heat to produce a certain amount of cold, H, the equation :

$$\frac{H_s}{H} = 6{\cdot}33\,\frac{T'-T}{T}$$

If the value of $\frac{T'-T}{T}$ is entered in a diagram (Fig. 11) as abscissæ (T' taken as 68° F.), and the value of $H_s$ (H taken = 1) is entered as ordinates, we get a curve ($a\ b$) which represents the theoretical minimum of $H_s$. In a second curve ($c\ d$) were represented

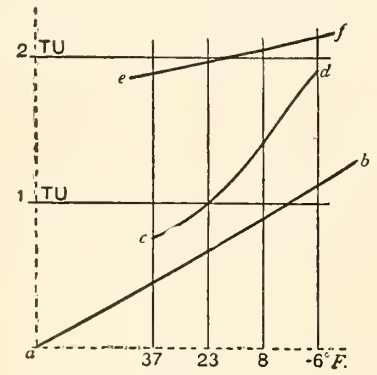



Fig. 11.

those heat units, $H_s$, which are actually measured in the ammonia compression machine tested at the trial station of the "Polytechnischer Verein" in Munich.*

How do absorption machines behave as compared with this result ? We have seen: the cold produced per lb. of ammonia circulated is :

$$H = r-(q'-q).$$

In the generator, without considering the water carried through the process, heat must be expended as follows: The latent heat ($r'$), plus the heat of absorption ($a$), and plus the specific heat ($c$) necessary for the superheating of the ammonia vapors from the temperature, T' to $\theta'$.

The result therefore is :

$$\left(\frac{H_s}{H}\right)\ \text{min.} = \frac{r'+a+c(\theta'-T')}{r-(q'-q)}$$

If we now plot in our diagram (Fig. 11) the values of $H_s$, corresponding to the temperatures represented by the abscissæ, we get the curve ($e\ f$).

By comparison of these three curves, it is evident that the performance of the required mechanical work can be done much more economically in a compressor than by means of the system of absorption and distillation, even if an apparatus could be constructed for the performance of this working principle, working without any losses whatsoever.

In the discussion that followed Mr. W. W. Beaumont said they had to thank Professor Linde for a really valuable paper, containing a great deal of important information—the result of his own researches —though, at the same time, he did not know that it contained any striking novelty, or any points which he had not dealt with in previous papers. Probably many present would be better able to speak on the subject from the practical or commercial side, which had not been touched upon. Few probably had any idea of the magnitude of the traffic now carried on by cold storage vessels, or of the continually greater and greater extent to which they were looking to foreign countries for the supply of food to the country, owing to the use of such vessels. Refrigerating machines had been much more amenable to scientific treatment on the thermo-dynamic side than almost any other class of machines. They had long been accustomed to see steam engines and other motors submitted to this kind of examination, but he was not sure that the steam engine had been much improved in consequence; but it was perfectly clear that refrigerating machines had gained in every way by such treatment, as had been so ably described. The point referred to as the difference between latent heat and liquid heat was one which lay at the bottom of the most important recent advances, but without going into that he would ask to what extent recent practice had shown that the theoretical difference in economy between the different classes of machines had been borne out. Even now air engines were still being constructed, and quite recently he had seen a large set of them being prepared for a large ship; there must be some reason for continuing the use of machines which, theoretically, were so much less efficient than others. Of the two other kinds, again, each found supporters among people who apparently knew what they were about; and one would like to know whether they were practically as different as they appeared to be theoretically

Mr. E. Hesketh said the author of the paper had certainly added a very important contribution to the somewhat scanty literature on the subject of refrigerators, but he wished he had reconsidered his position before again committing himself to the statements he had made on the subject of carbonic acid. It was stated, and appeared by the diagrams, that the efficiency of carbonic acid was practically nil when the cooling water was at 88° F., but that was distinctly not the case, as was shown by the fact that there were at present over forty carbonic acid machines working constantly through the tropics, where the water was often higher than 88°, and they were working perfectly satisfactorily. He assumed the statements made with regard to carbonic acid were based on theoretical considerations and experiment, but they all knew how difficult it was to experiment with such matters as liquid carbonic acid or ammonia, and he could only conclude that an error had crept in somewhere. It had been suggested that such machines, when the water was at 88° or over, worked in the same way as an air machine, that the carbonic acid did not liquefy, but that some sort of action took place, similar to that shown on the diagram. The fact, however, that these machines were working through the tropics without any expansion cylinders whatever disposed of that suggestion, and showed that a similar action took place above 88° as below.

He had seen many machines at work when the water was at 100°, and still acting efficiently. One important point which had not been touched upon was the safety of the material used, and, in this respect, ammonia could not be compared with carbonic acid. Every one knew how poisonous and offensive were the fumes of ammonia, but, with carbonic acid, the whole contents of a machine might be allowed to escape into a room without any fear of deleterious consequences. One effect of that was this, that in designing a machine, it was absolutely necessary that on both sides of the compressor there should be stop valves, so as to be able at any time to open the compressor and bottle up the chemical in the evaporator and condenser. If, by any chance, the attendant neglected to open his delivery stop valve, the consequences would be very serious, but in the case of a carbonic acid machine, a safety valve could be put in at that point, while with an ammonia machine such a remedy would be almost worse than the disease. There was no evidence to prove that carbonic acid machines were less efficient than ammonia machines, and even if it were so, the greater safety of using the former should have weight in deciding which was best to use.

Colonel Cunningham said he had seen several ammonia machines at work where the temperature of the air was over 100° and that of the water was probably over 88°. The offensive smell of ammonia was a great protection in the case of a domestic machine, as it gave you warning something was wrong. The danger no doubt was very great in the case of an explosion. He knew of one case in which a machine was blown up, belonging to a brother officer, and though he was not injured by any of the fragments, he died within a day or two from the effects of the ammonia

Professor Linde, in reply to Mr. Beaumont, said the progress of the different systems showed that practice was quite in accord with theory. The ammonia compression machine was by far the most used now. The reasons for the exceptions were so manifold that he could not attempt to go into them. He did not think Mr. Hesketh could have followed his explanation of Diagram 9. He explained that when the carbonic acid was coming from the condenser at 88°, the critical point, or higher, the whole amount of latent heat was consumed by the liquid heat in reducing the temperature of the liquid carbonic acid; the same amount of heat was taken away as was gained by evaporation. Mr. Hesketh suggested that his figures were not right, but he could only say that no other point in the whole theory of heat had been the subject of so much scientific research during the last few years as the state of carbonic acid at the critical point. It did not follow that a machine would cease to act at that temperature, because, as he had explained, it was possible to go far below the temperature, T, with the vapors; and then to raise their temperature in the evaporator. When the carbonic acid entered the refrigerator it was in a state of saturated vapor; but if they were at a temperature of, say, zero, and the brine was maintained at a temperature of 23° F., then the temperature of the vapors could be raised in the refrigerator from zero to 23°, thus abstracting a certain quantity of heat from the brine, and so producing cold. That amount was represented by C D on the diagram. It was simply impossible to produce cold under such conditions with a smaller amount of work than the theoretically necessary amount represented by the whole area of the diagram. Cold air machines had brought cargoes of meat in very good condition through the tropics, and the carbonic acid was in a much better condition than air, because one pound of carbonic acid vapor took much more heat from the brine than a similar weight of air, its specific heat being much greater. It was a mistake to suppose that such a production of cold could not take place without an expansion cylinder. When air expanded from high pressure to low pressure it was necessary that it should do work on a piston, otherwise its temperature would not be diminished. If the air expands without doing work on a piston, then work is done on the air to give it a high velocity, which work might be termed living power. When it came to rest in the room, that living power was again returned in heat. In the case of carbonic acid, when it flowed from the condenser to the refrigerator, the work was not done outside, as in the case of the cold air machine, but internally; as the volume grew there were enormous internal forces at work, and the equivalent of this work replaces the outside work in the cold air machine. There was only one way of definitely settling such questions and that was by public experiment. In Munich there was a large testing station to which manufacturers were invited to send their machines for trial by a commission consisting of the highest authorities in Germany, Professor Zeuner being president. The tests were made in the presence of the commissioners and of the competitors, so that the results were perfectly trustworthy. The safety of different systems must be judged by experience, and the way to test them would be to take the number of machines made on each system and multiply them by the time they had been in work, and then ascertain how many accidents had occurred in each. In that way a fair comparison could be made. The result would show that carbonic acid was much more dangerous than ammonia, the reason probably being that the working pressure was from six to eight times larger. He knew of at least three accidents with carbonic acid machines; one occurred at Bar le Duc, where the attendant was killed by the explosion of the cylinder; one at Guinness', in Dublin, where no personal injury was sustained; and one in a vessel at Buenos Ayres, where a carbonic acid bottle exploded when it was being used to charge the machine, and two persons were killed. There were probably 40 times as many ammonia machines at work as there were of carbonic acid, and they had been working at least three times as long, so that there ought to be 120 times as many accidents in order to show that they were equally dangerous; but he did not believe it would be possible to find even 40 or 50 such accidents.

* See "Bayerisches Industrie and Gewerbeblatt," No. 25, 1893.

[Continued from Supplement, No. 953, page 15225.]

## WATER TUBE BOILERS.*

In our last impression we sketched in Fig. 10 a form of header, and we stated that, so far as we knew, no boiler was constructed precisely in that way. It is proper to point out before going further that in saying this we referred only to land boilers. The latest type of Lagrafel-d'Allest boiler, constructed for marine purposes by the Forges et Chantiers de la Mediterrannee. almost complies with our description. A sketch of this boiler will be found in Mr. Milton's paper read before the Institution of Naval Architects, at Cardiff, and published in our issue for July 21, 1893.

The object had in view by designers of express boilers is the production of a steam generator which shall be as light and as small as possible for its power. We shall have a good deal to say further on this branch of our subject; but for the moment our business is not with weight or dimensions, but with the special features or characteristics of express boilers. Generally speaking, all boilers of the kind have tubes of comparatively small diameter. There are three prominent varieties. First, modifications of the Root type, under which head may be included the Belleville boiler, a sketch of which as used in the French navy we give in Fig. 10a, and some others with tubes smaller and shorter than those of land boilers; all these bear forcing moderately well, but they are not express in the full sense of the term. Secondly, coil boilers of various types, such as the Herreshoff, which stand forcing very well. And lastly, express boilers in the full sense of the word, of which those of Thornycroft, Yarrow and Normand are the best known.

It is not, we think, necessary to dwell at any length on the Belleville boiler, because nearly all that we have already said applies to it and to its congeners with more or less pertinence, and our readers will not be slow to understand in what way it is better or worse in principle than other water tube boilers of this type. The coil boilers are peculiar, and require explanation. The use of coils has been common enough. Coiled tubes present a great deal of heating surface in a small space. They are used either with or without steam drums or their equivalent. When combined with a drum the coils are usually short; sometimes, indeed, the so-called "coil" is little more than half a turn of tube. Several coils may be combined with a central drum which they surround. In fact, the ways in which they may be arranged are almost endless. On the whole however, boilers of this kind do not appear to be very satisfactory. To some extent the free rush of water and steam through them is hampered, and the tubes are punished in the bending. Certain it is that various boilers of this type have given trouble by splitting their tubes, and these are not easily got at for plugging or repair.

However, all boilers of the kind of which we have knowledge possess the advantage secured by letting each tube have a free delivery into the steam drum, so that fighting between two tubes never can occur. Undoubtedly, however, the best type of coil boiler is that in which the whole of the heating surface is disposed in a very small number of tubes. It is clear, however, that these tubes must be very long. Roughly speaking, each foot in length of a 2 in. tube represents half a square foot of surface. To get 500 square feet we shall need a tube 1,000 ft. long. Such tube disposed in two sets of coils would give a boiler not more than 7 ft. in diameter by about 8 ft. high, and each square foot would probably evaporate 10 lb. of water per hour, so that with a triple expansion engine the boiler would supply steam for 500 or 600 horse power. But those who have read what we have already said concerning circulation will readily understand that, inasmuch as the coils of pipe must be nearly horizontal, it would be impossible to get sufficient natural circulation through a pipe of such enormous length.

Coil boilers of this class therefore have been almost

* From the *Engineer*, London.

invariably worked with forced circulation, a pump driven by the engine forcing water continually through the tube. John Elder's boiler, patented in 1862, is one of the early examples of the type. He used a spiral fan or propeller to drive the water in at the top of a

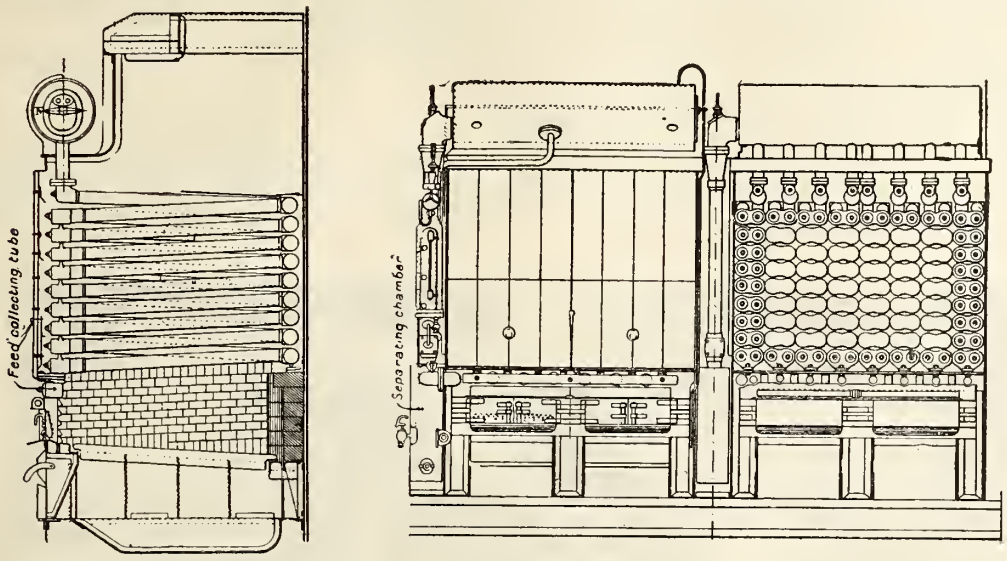



Fig. 10*a*.

tall coil. The steam and water escaped at the bottom into a vertical drum considerably taller than the coil. The upper part of this drum was the steam space. Fig. 11 will suffice to indicate the general features of the arrangement. A is the propeller and B is a pulley driven by a belt from the engine. As far back as 1824, Paul patented a boiler of this type, with a force pump to maintain circulation. The water entered at the upper end of the coil and steam was delivered at the bottom. No attempt was made to provide a steam drum, as the inventor proposed that all the water should be converted into steam before it escaped from the lower end of the coil. Benson's boiler, which made some stir at one time, was a coil boiler with forced circulation, patented in 1858. Since those days many other boilers have been made by various inventors, among whom may be mentioned Herreshoff and Yarrow.

This type of boiler has never yet, we think, had justice done to it. Under proper conditions it is capable of unlimited forcing, being indeed an express boiler in the fullest sense of the term. But it is open to considerable objections on the ground that a small failure in any part of the length of the tube renders the whole boiler *hors de combat;* whereas in boilers with many tubes, if one is burst it may be plugged, and the boiler is then capable, after a little delay, of working as well, or nearly as well, as before. For small boilers

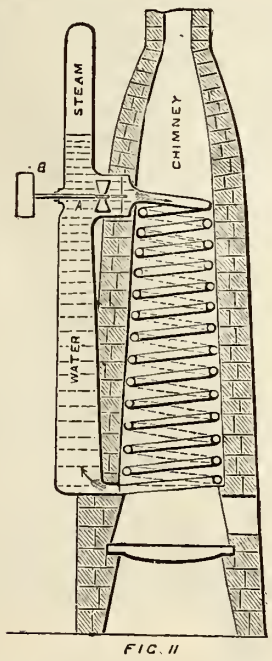


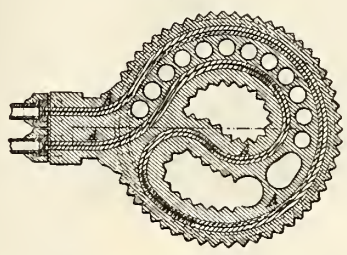

FIG. 11

for steam launches, however, the system ought to work very well, especially as there is no delay in getting up steam; a pressure of 120 lb. can readily be had in a quarter of an hour, and the boiler is quite safe in that a split tube is most unlikely to cause an accident. It would be quite possible to adapt the principle to larger powers, by using a number of coils instead of one, the circulation being maintained by a single pump. This will have very little to do, the pressure being very nearly the same on both sides of the piston. We have already described a modification, however, when some work would be thrown on the circulating pump, the steam and hot water being delivered into the drum under pressure. An objection to coil boilers without water drums is that the pressure is very unstable, flying up and down from minute to minute as the fire varies. It is usual, therefore, to load the safety valve to considerably beyond the working pressure to allow a margin. Although not strictly a water tube boiler, in the sense in which the words are used in these articles, we cannot omit mention of the Serpollet boiler, illustrated by Fig. 11*a*, which is a plan. It consists of heavy cast iron blocks incasing a steel tube flattened until the opening through it is less than one-twentieth of an inch wide. Water is pumped through this, and converted into superheated steam. We have already fully described the steam carriages to which M. Serpollet has applied his boiler with much success.

We have said that the modern express boiler is a new departure in engineering, and we think the fact will be fully recognized before we have done. It is the result of the labors of two engineers, Mr. Thornycroft and Mr. Yarrow. In certain respects their boilers are alike, in others totally distinct. We shall begin with the Thornycroft boiler, which was indeed first in the field.

There are several distinctive and original features in the Thornycroft boiler. It consists essentially of a central horizontal steam drum, two horizontal water supply tubes, and a number of small diameter tubes uniting the others. The first point to be noticed is

Fig. 11a



that instead of a number of tubes discharging into a single header or riser, which in turn opens into the steam drum, each individual tube opens directly into the steam drum. Thus each tube acts for itself, and cannot fight with its neighbors for precedence in delivery. The tubes are long, but they are of small diameter—about 1 in. inside—and they are made of a very special soft steel. We have no intention of describing here the methods of manufacture. Fig. 12 shows the principle.

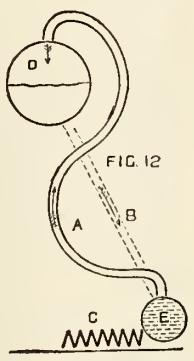



FIG. 12

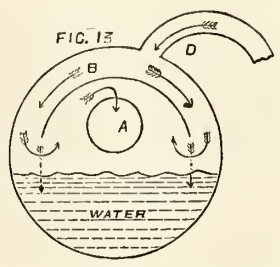



FIG. 13

We have shown only steam-making pipe, A, and one down pipe, B; the grate is C. One of the first points to be noted is that the tube, A, enters the drum, D, at the top. A very great quantity of water is carried up with the steam. If the steam and water entered at the bottom of the drum, they would cause a violent commotion; by coming in at the top the water is projected downward, and separated by its momentum from the steam. The anti-priming arrangement inside the steam drum is very simple; it is shown in Fig. 13. Here A is the steam pipe which runs from end to end of the steam drum. It is provided with saw cuts all along the top; B is a deflector plate—a pent-house or roof, in fact, over the steam pipe, on which is delivered the rush of steam and water from the tubes, one of which is seen at D. The water is thus knocked out of the steam and falls straight down, as shown by the dotted arrows. The scheme is quite effectual, and the boiler supplies dry steam. At first sight it would appear that a boiler of this kind must have a steam drum, D, Fig. 12, and "feeders," E, of sufficient diameter to permit a man or, at all events, a boy to get inside in order to fix the tubes in D and E.

Obviously this would limit reduction in dimensions. To Mr. Thornycroft, however, is due the credit of so contriving matters that tubes as small as 10 inches in diameter can be used for E. A special roller tool is used, which can be introduced through the end of E, which is fitted with a removable lid. The roller tube expander, carried on the end of a staff, can be put in place, and worked by a ratchet gear; the tubes being secured by rolling with almost as much ease, and nearly as quickly, as though direct access could be got to them. This may appear at first sight a small thing, yet it is nothing of the kind. The fact that it is possible to secure tubes in this way, and to make water and steam tight joints at a distance of 5 feet or 6 feet from the operator, is one of very great importance, and, in certain respects, revolutionizes the construction of tubulous boilers. When we come to consider the question of weight, it will be understood what the innovation really means. The success attained by Mr. Thornycroft stimulated invention in the same direction, and numerous patents have been taken out, especially in the United States, for boilers using small tubes combined with feeders and drums. Fig. 14, pat-

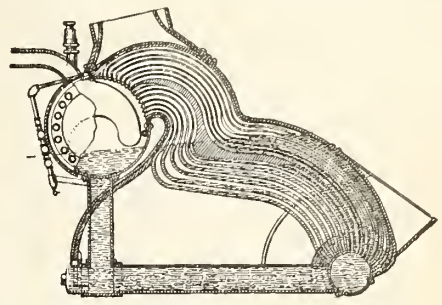


Fig. 14.

ented by Messrs. McBride & Fisher, of Philadelphia, has been fitted to a large launch which has attained a very high speed, and great success is claimed for the generator, concerning which we shall have more to say. It will be seen that it very closely resembles one side of a Thornycroft boiler. Fig. 15, another American boiler, speaks for itself. Fig. 16, although a land

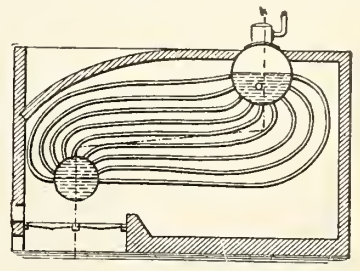
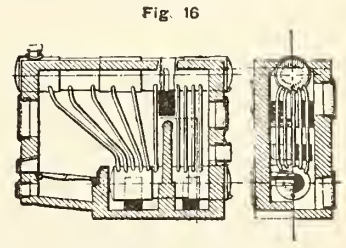


Fig. 15.

boiler, involves much the same general principle of construction.

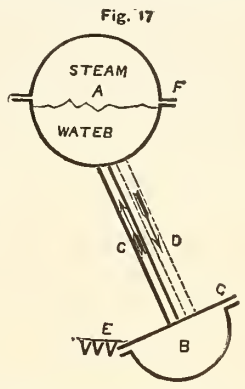
The Yarrow boiler has certain features in common with the Thornycroft boiler. Thus, it consists of a central steam drum above and two water feeders below, united by the steam generating tubes, which are of small diameter; but here the resemblance ceases. Following the plan we have adopted with the Thornycroft boiler, we only give in the annexed sketch a single tube of the Yarrow boiler. Here A is the steam drum, B a feeder, C a generating pipe, and D, dotted, is one of two or more down-flow pipes, E is the grate.

Fig. 16



The steam drum has a horizontal bolted joint all round, and the water feeders consist each of a flat tube plate and a semicircular lower half bolted together. In this way access is got to both ends of the tubes. Indeed, the tubes and the upper plates of the feeders, and the lower half of the steam drum, are put bodily into a galvanizing pot and coated all over with zinc to prevent that external corrosion to which all boilers of this type seem to be liable when not in use. This has been a very successful steam generator, and, although the pipes deliver into the lower portion of the drum, the boiler supplies very dry steam to the engines, special precautions being taken in fitting the steam pipe to attain that object. So far as can be seen there

Fig. 17




is nothing to choose between the Yarrow and the Thornycroft boilers as steam makers. In attempting to arrive at a conclusion respecting the relative merits of two different boilers, it is impossible to ignore the surrounding conditions. We shall show in a subsequent article that express boilers are mainly judged—other things being equal or nearly so—by their weight. The lighter the better. Now one of the very first points to attend to in designing a light boiler is to avoid the use of any heating surface that falls in efficiency below a certain minimum. Putting this in a different way, it amounts to saying that no generating tube should have any portion of its length non-efficient. If we compare the Yarrow and Thornycroft boilers, it will be seen that the tubes in the former are shorter than those in the latter. If we suppose the weight of the boiler to increase or diminish precisely as the length of the generating tubes increases or

diminishes, then the Thornycroft ought to be heavier than the Yarrow boiler for a given power, unless it can be shown that each foot of length of tube is as efficient in one as in the other. It is clear, however, that this cannot be the case, because the upper portions of the Thornycroft tubes are far removed from the fire. We have no means of knowing what are the weights per horse power of the two boilers; we suspect they are very nearly alike, but that must obviously be because some other factor than tube length has to be considered. Thus it seems clear that the Yarrow feeders must weigh a good deal more than the Thornycroft feeders. We have used these boilers in this case to illustrate our proposition. The point is constantly overlooked, and we find in some boilers intended to be as light as possible, surface weighing from 5 pounds to 20 pounds per square foot that is really incapable of generating steam or serving any good purpose whatever. It is sometimes urged that unless surface is supplied the evaporative economy of the boiler will be reduced. This is a matter of small consequence in express boilers, unless, of course, the inefficiency is very well marked. The proper course to pursue is to decide upon some one coefficient, and to work that. Thus we may decide that no surface shall be held worth having unless it will evaporate 3 pounds of water per square foot per hour. But of course any other coefficient may be selected. Again, the boiler designer must never forget that mere proximity to the fire or the reverse does not alone fix the rate of evaporation or the economy of fuel. It will be time enough to enlarge on this point, however, when we come to speak of the way in which the heat is supplied, applied, and distributed in water tube boilers.

We have now, we think, shown in what lies the main difference between the express and the ordinary water tube boilers. In brief, it consists in the use of small tubes of considerable length in proportion to their diameter, and more or less nearly vertical, in the express boiler, each tube delivering independently into a steam drum; while the ordinary water tube boiler has tubes of larger diameter, set nearly horizontal, and delivering in quantities of eight or twelve into headers or risers, each of which delivers into the steam drum.

The adoption of the small tube system, and the success which has attended it, has, as we have said above, stimulated further invention, and many boilers are proposed or being made which more or less resemble the Thornycroft and the Yarrow steam generators. Among these may be mentioned the boilers made by M. Normand, of Havre. Furthermore, the principle is being adopted in boilers for ordinary marine service under conditions which do not dictate minimum weight. It is by no means probable, indeed, that invention has nearly covered the whole ground, and it is not impossible that something better may yet be produced than anything now in the market.

*(To be continued.)*

## DE LAVAL'S STEAM TURBINE.

In every disinterested and impartial mind it is now well established that the days of the ordinary steam engine are numbered.

From the standpoint of the conversion of thermic energy or heat into mechanical energy work, the modern gas engine is already infinitely superior to it, since it converts 16 per cent. of the heat that it receives into mechanical work. The best organized steam engine attains half such a result with difficulty. With equal calorific power the high price of illuminating gas is the sole obstacle to the substitution of the gas motor for the steam engine; but tentatives have already been made, with success under certain circumstances, to substitute for illuminating gas poor gases obtained directly in special generators, and to suppress the use of steam. Under such conditions, one horse power has been obtained upon burning 20 ounces of anthracite with a motor of 75 horse power only—a consumption to which it would be impossible to descend in employing the most improved steam motor. The steam engine is therefore no longer the best thermic motor known and constructed.

But even in accepting steam as the necessary intermediary between the heat developed by the combustion of coal and the work to be produced upon a shaft, the ordinary process of conversion by engines having cylinders, pistons, connecting rods, cranks, eccentrics, rods and distributing slide valves seems superannuated to some. For some years there have been constructed and employed upon a large scale rotary motors of high angular velocity (from 6,000 to 12,000 revolutions per minute), in which the expansion of the steam in a series of turbines produced the revolution of the shaft directly without any of the parts that we have just enumerated. The Parsons turbine is the best known and most widely distributed motor operating under such conditions.

But there was still one step to be taken in this direction. Instead of effecting the expansion of the steam in the motor itself, why not utilize such expansion for communicating a great velocity to the steam and utilize the kinetic energy thus gained by the latter for directly actuating a true steam turbine, just as water actuates a hydraulic one through its velocity and kinetic energy?

This step has now been taken. Mr. De Laval's turbine, which we are going to describe, realizes precisely the conditions enumerated above. It consists of a bucket wheel, with a horizontal axis, the buckets of which are struck by the steam coming from the boiler and possessed of a great velocity due to its previous expansion in an ajutage properly widened out to this effect. The steam communicates its kinetic energy to the buckets and escapes through the other face at a reduced velocity. The general principle of action is the same as that of hydraulic turbines. The steam must enter without shock and make its exit without velocity, in order that the apparatus shall be placed under the best possible conditions of rendering.

The body of the turbine consists of a slender steel shaft upon which is mounted a steel disk upon the periphery of which are formed the buckets upon which the steam acts (Fig. 1). The disk is surrounded by a steel ring designed to close the buckets of the turbine, prevent vortices of steam and suppress the resistances that would be met with by the ends of the buckets in the atmosphere, being given the great velocity (from 500 to 650 feet per second) that is communicated to them. The disk revolves in a cast iron chamber, one of the sides of which serves for the entrance of the steam through one or more ajutages. The other serves for the exhaust. As the angular velocity of the wheel is very high (from 15,000 to 30,000 revolutions per minute, according to the power), it is reduced in the ratio of 10 to 1 through a pair of helicoidal gearings whose teeth, inclined at an angle of 45 degrees and in opposite directions, assure a very gentle motion and prevent any longitudinal motion of the disk in the direction of its axis. The pinion of this pair of gearings is of steel. The wheel has a steel nave and a rim of bronze. Under these conditions the friction is steel against bronze, and this spares the pinion, the teeth of which do ten times more work than those of the wheel.

It is upon the axis of reduced velocity that is mounted the centrifugal force regulator, which acts upon the admission through the closing of a balanced valve placed at the entrance of the steam into the apparatus.

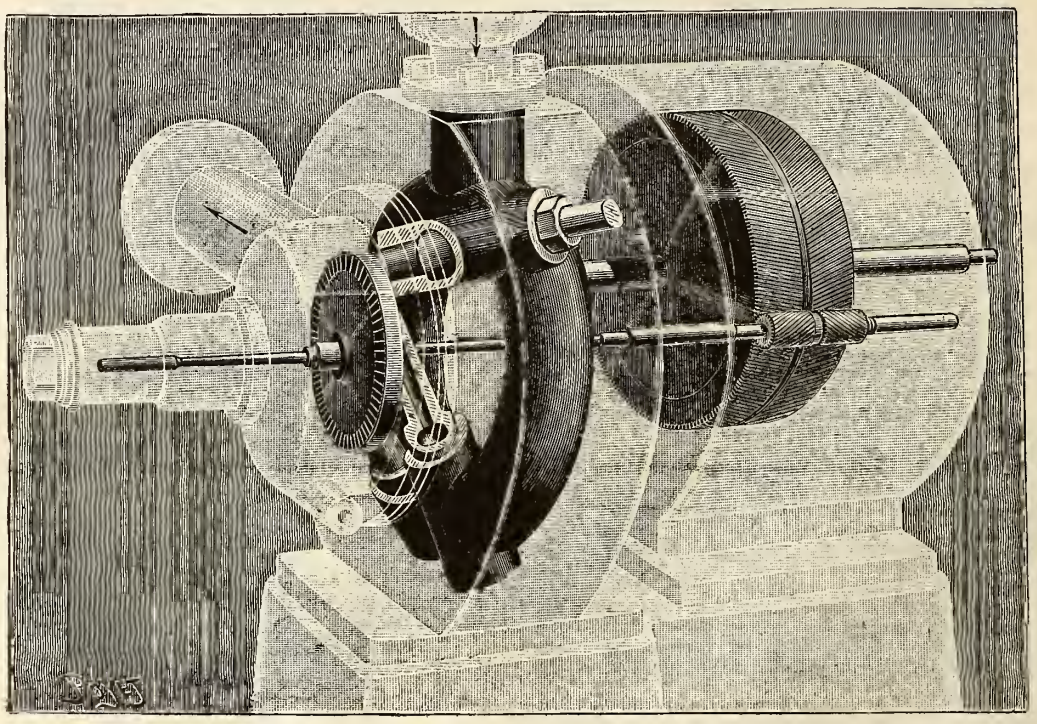


Fig. 1.—THE DE LAVAL STEAM TURBINE.

The jacketing of the motor and gearings is supposed transparent in order to allow the essential parts of the system to be seen.

The power of the apparatus is made to vary by opening a variable number of ajutages, so that the same motor is capable of operating under very favorable conditions of power, while at the same time preserving sensibly the same rendering.

As the steam acts only by its velocity, and not by its pressure, since it is expanded before acting, and escapes at nearly the pressure of the atmosphere or at that of the condenser, there may exist between the bucket disk and its jacket a play of 0·08 inch, so that no friction of metal against metal occurs other than that of the anti-friction metal pillow blocks, which, moreover, are of small diameter and long range.

The steam turbine of 10 horse power that we shall take as a type is but 36 inches in length, 19 in width, and 34 in height. Its weight does not exceed 440 lb. The axis of the turbine runs at the angular velocity of 24,000 revolutions per minute—say 400 per second. The steel disk is but 5·25 inches in diameter and 0·5 inch in thickness. Its periphery thus moves at a velocity of 577 feet per second. Under such conditions, the tangential stress upon a circumference of 2·75 inches radius is scarcely more than 8·8 lb. when the machine is producing its 10 horse power, and this justifies the small dimensions of the driving shaft, the diameter of which does not exceed 0·3 inch in the part comprised between the disk and the pinion, and but 0·2 inch in the part opposite the gearings. The parts of the shaft revolving in the bearings are respectively 0·46 and 0·3 inch in diameter.

On the contrary, the effect due to centrifugal force is much more important. Upon applying the well known formula

$$F = M\omega^2 r$$

in which M is the mass and F the force exerted upon it at a distance, $r$, at an angular velocity, $\omega$, we find that the force exerted upon a mass of 15 grains placed at the circumference of the turbine of 2·75 inches radius is 96 pounds, say 44,000 times the action exerted by gravity upon such mass. In the more powerful types, the centrifugal force exerted upon a mass of 15 grains exceeds 110 pounds. It will be conceived that, under such conditions, the least defect in the centering or in the homogeneousness of the material would produce lateral stresses and vibrations at the expense of the silent running of the turbine and of its rendering. This difficulty has been very ingeniously overcome by Mr. De Laval by mounting the disk upon a long and elastic shaft capable of undergoing a certain flexion. If, under the action of the unequally balanced masses, the disk tends to become eccentric, the flexible axis twists slightly and through its torsion brings back the center of gravity to the real axis of revolution. The defect in symmetry is thus automatically compensated for.

Fig. 2 shows an application of the steam turbine to the running of a dynamo (Manchester type) making 2,400 revolutions per minute. The weight of the whole turbine, gearings and dynamo, is less than 1,300 pounds for an effective 10 horse power.

In powers exceeding 20 horse, the pinion actuates two toothed wheels placed symmetrically on each side of the axis of the turbine properly so called, and in the prolongation of the axes of these wheels are mounted two dynamos of equal power that may at will be

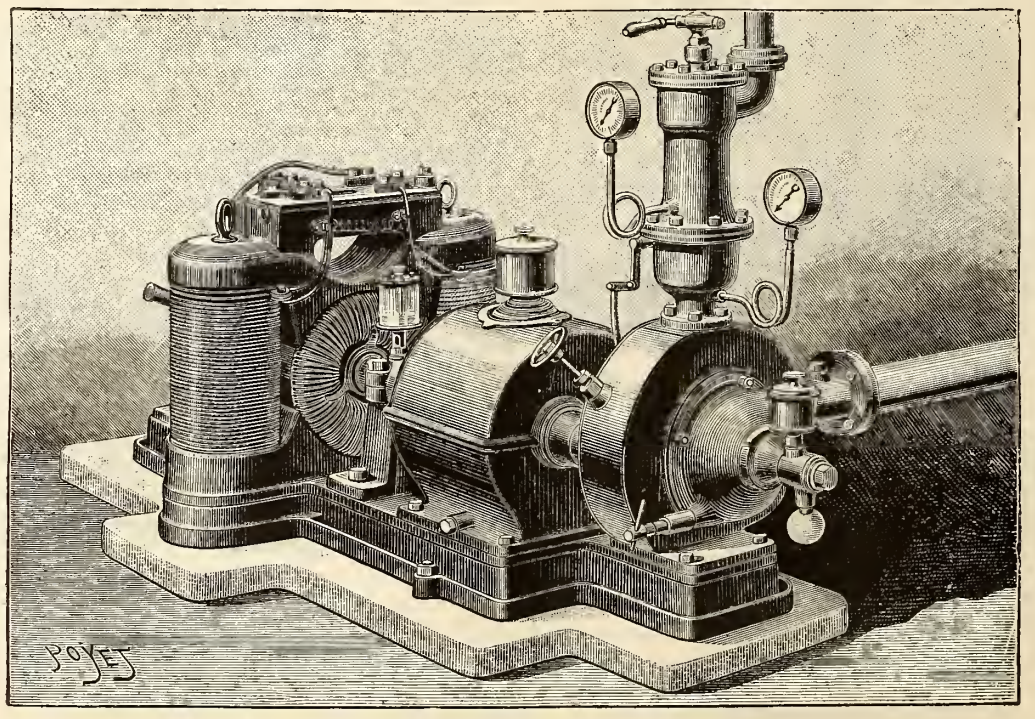


Fig. 2.—TEN HORSE POWER STEAM TURBINE DRIVING A DYNAMO.

coupled in tension—an arrangement just the thing for small central stations that distribute electric energy with three wires, or in quantity, if the distribution is made with two wires.

In consequence of the great angular velocity of the steam motor, the system as a whole presents proportions the reverse of those to which we are generally accustomed. It is the motor which has by far the smallest dimensions; then come the gearings, with their cast iron jacket, and finally the relatively reduced angular speed dynamo.

When the steam turbine is to actuate anything else but a dynamo, the extremity of the shaft of the toothed wheel carries a pulley over which passes a driving belt.

Seeing the great velocity of this belt (80 feet per second), it is well to make it without joints and provide it with a tightener.

The advantages claimed in favor of this motor are its simplicity, the small space that it requires, the absence of foundations and parts in friction aside from the pillow blocks, the regularity of running due to the constancy of the motive couple, and the ease with which a condenser may be adapted.

The consumption of steam does not exceed that of ordinary motors of equal power, while the cost of lubrication, there are no less than a hundred apparatus in service in the Scandinavian peninsula, varying between 5 and 100 horse power. Three hundred horse power types are now under study and will soon be constructed. A French company, the Societe de Laval, has just been organized under the superintendency of Mr. Sosnowski, and has intrusted the construction of its machines to the Breguet establishment, where, thanks to the politeness of Mr. G. Sciama, we have been enabled to examine the so simple, so interesting, and so original apparatus that we have just brought to the notice of our readers.

A dozen years ago, steam engines were of so low speed and dynamos of so high, relatively, that it was often necessary to establish two intermediate transmissions before it was possible for one to actuate the other; but, step by step, we at length succeeded in employing but a single intermediate transmission, then a direct driving by belts, and finally a direct coupling, the dynamo being mounted in the prolongation of the motor's axis; and the angular velocity of steam motors ever kept increasing. It even increased so rapidly that the Parsons turbine, which made from 9,000 to 12,000 revolutions per minute, had to descend to 6,000 revolutions in order to be able, industrially, to actuate directly coupled dynamos; and still the angular velocity of steam motors kept increasing, so that to-day, with the De Laval turbine and its 24,000 revolutions per minute, a train of reducing gearings becomes indispensable. The steam motor revolves too rapidly and the dynamo not rapidly enough. In twelve years, the evolution of progress has reversed th ' terms of the initial ratio. This fact ought to render us prudent and reserved.

The De Laval turbine has warm and enthusiastic partisans, as it has bitter detractors. This is the fate of all new things, and we have recently had another example of it apropos of the Heilmann locomotive. For one as well as for the other let us be content to register the facts acquired, and patiently await the data of experience, the only master that never deceives and is never deceived.—*E. Hospitalier, in La Nature.*

## THE STATE DAM, MOHAWK RIVER, AT COHOES, N. Y.

This work is known as the "State dam," in contradistinction from the dam of the Cohoes Water Power Company, located about a mile above the falls, and by its means and a bridge the boats on the Champlain or Northern Canal are enabled to cross the river, which at this point is 1,700 feet wide. Several previous dams built here have been carried away.

Fig. 1 shows the method of constructing the apron. Strong ribs grooved on their inner edges are secured by braces to the masonry of the dam and then sheets of iron are introduced between the ribs, as shown in our engraving. The lower half of the apron is first built and the space between the iron plates and masonry filled in solid with concrete cement, then the upper half is made in the same manner and the cement carried up behind the iron plates to the top.

The top of the dam is finished, as seen in Fig. 2, by laying strong girders, which are firmly anchored to the masonry coping, and upon the girders iron plates are attached, the interstices between the girders and covering plates being solidly filled with hydraulic cement or concrete. The whole work is of the strongest and most substantial nature.

Fig. 1.—THE IRON APRON.

Fig. 2.—SHOWING THE TOP FRAME.

Fig. 3.—BACK VIEW OF GIRDERS.

Fig. 4.—PLATING OF TOP GIRDERS AND APRON.

## THE NEW YORK STATE DAM, MOHAWK RIVER, AT COHOES, N. Y.

The dam is built by Messrs. Cunningham & Morety, under contract with the State, the price to be paid being $90,000. For the photographs from which our illustrations are made we are indebted to Mr. Chas. McGovern, of Cohoes, N. Y.

### A RAILROAD OVER THE NEVA.

When winter has bound the beautiful broad Neva in its chains, it is the scene of greater activity than when free from ice. Good courses are laid out for skaters, Laplanders settle on it with their tents and reindeer, and various means of communication are opened to take the place of steam and other boats used in summer. It is well known that St. Petersburg has too few bridges across the Neva, an inconvenience that is much felt in summer, but in winter nature throws ice bridges over it, only a little aid being required from the hand of man. Wagon roads extend diagonally over the ice from many parts of the quay, being marked off by evergreen trees, and these relieve the bridges of much traffic, and sometimes save a detour of several wersts. Footpaths are laid out and lighted at night by lanterns, and near by

### Oranges as Soap.

Oranges as Soap.—Housewives in Florida scrub their floors with oranges. In almost any town in the orange-growing districts women may be seen using fruit exactly as we use soap. They cut the oranges in halves, and rub the flat exposed pulp upon the floor. The acid in the oranges does the cleansing, and does it well, for the boards are as white as snow after the application.

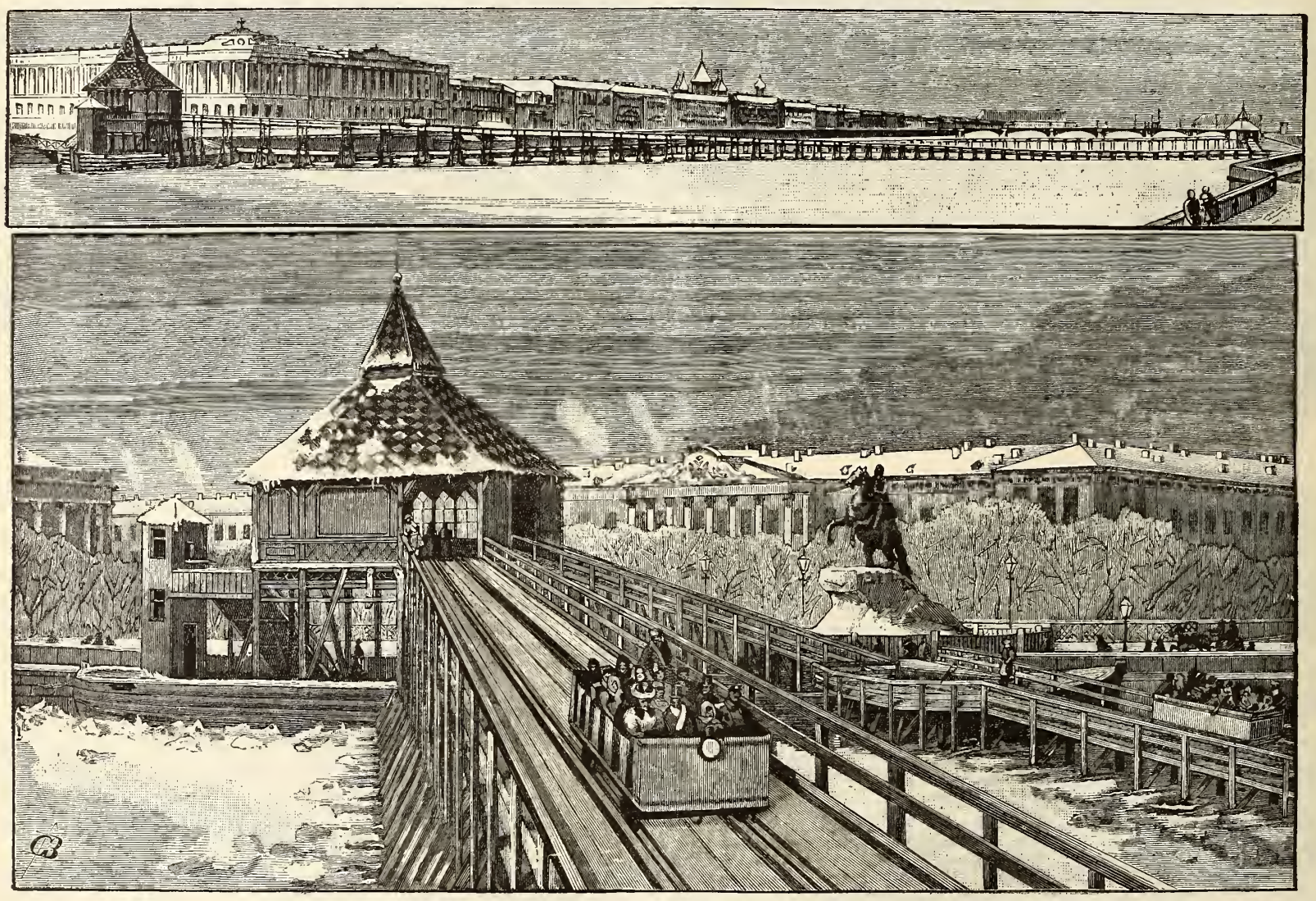
there are roads over which passengers can be taken in sleds pushed by men on skates.

This year a gravity road was opened by the energetic Finnische Passagierdampfer-Gesellschaft, the company which keeps steamboats on all the rivers and canals of the city and its suburbs from spring until late autumn.

There is a high tower on each shore, and from each of these towers runs a structure for a gravity road, reaching the opposite shore at a level with the quay. These structures rest on more than a hundred supports, which, in turn, are fastened in a frame of beams that rest directly on the ice. Rails are laid on the floors of these bridges, on which the broad, low cars run on small wheels. These cars are controlled by brakes. Each car can accommodate twenty passengers, and when it is time for a car to start it is pushed out of the room in which they stand upon the inclined track, and in less than a minute it rolls by gravitation across the Neva to the tower on the other side, where the brakes are applied at the proper time and the car is caught by two other guards. The distance covered is about half a mile.

The thing is very simple, but cost a great deal—about $9,000. The work consumed a great deal of time and a large quantity of wood was required for the structure. The unusually warm winter delayed the work, the ice not being uniformly secure. As many experiments and improvements of the track were necessary, the road could not be opened before the middle of January. It is very popular and meets with great encouragement; so much so, in fact, that any one who is in a hurry prefers not to go by the road, for he runs the risk of standing in front of the ticket office up in the tower for an indefinite length of time. Many enjoy the ride so much that when they have once started they make the trip several times. The fare is very cheap—about 1½ cents.

It is a question whether the receipts for this year will cover the expenses. The road certainly does not improve the appearance of the Neva.—*Illustrirte Zeitung.*



A RAILROAD OVER THE ICE OF THE NEVA, ST. PETERSBURG.

## HOW WAR VESSELS ARE PREPARED FOR TRIAL.*

By Robert W. Peck, of New York.

Members of the Marine Engineers' Beneficial Association in Cleveland were favored, at their last meeting, with an address by Robert W. Peck, a gentleman who is well known to marine engineers and ship builders in the East, as he has acted in the capacity of superintending engineer on the trial trips of nearly all of the United States cruisers other than those built by the Cramps. Mr. Peck's duties in Cleveland at present are of a similar nature in connection with the preparations for bringing out the Northern Line passenger steamer Northwest. At the same meeting, Mr. G. L. H. Arnold, who is associated with Mr. Miers Coryell in looking after the construction of the Belleville boilers, read the paper on this type of boiler, which was prepared a short time ago by J. A. Courier, engineer of the yacht Wild Duck, and which was printed in the last issue of the *Review.*

Mr. Peck's paper, or address, was not one of a formal kind. It was more of an interesting talk to the engineers, and pertained mainly to his experience in preparing war vessels for the trials in which premiums or penalties are involved. Stripped of the introduction, which had reference to the nature of contracts for war vessels, and a few other parts dealing with the calling of engineers in general, it is as follows:

"As engineers, the matter which I think most interests you is the management of the engine department of these cruisers while preparing them for trials. The record obtained during these trials, whether speed or horse power, goes with the ship, and all of the vessels with which I have had to do when making these trials can, I think, by proper manipulation, do the same or even better again, at any time before age or other causes shall have weakened the elements used to make the trials. To be employed by the contractor you must have a reputation as an expert in that particular kind of work, as money is at stake with the builder as well as his reputation. You will understand that, although these engines are designed by able men, whose work is as near perfect as they can make it, it does not follow that the work of the machinery will be entirely satisfactory. On this account your knowledge and skill will be wanted. If you meet the requirements, you will probably be well remunerated for what you do. If you do well, it generally follows that the contractor is pleased, and that he will not forget to show you that he appreciates the favor you have done him by being the means of replenishing his bank account. The short way to say this is that you must be able to know what to do to make the machine do the most, and to make any changes necessary for such performance. My experience has been that some alterations are necessary in several of the parts before it is possible to get a satisfactory performance, and I have come to the conclusion that this is to be expected. I have found it with engines I have designed myself. I have said that you must be able to make these changes. That it is well for you to be able to do so as an engineer, there can be no doubt, but will the contractor or the owner permit you to do so? It would seem that if he had confidence enough in you to employ you for such an undertaking, he would trust to you to use your own judgment. In my experience I have found that when I came to the turning up of the engine and it was necessary to alter any of the parts, the leading men of the different companies were opposed to anything in the way of an alteration and it was necessary to do considerable talking to gain a point in that direction. This is one of the disagreeable features of such trial trips, but usually by keeping your head level you will get along very well, and before the time for the final wind up, which is the official trial, you will have your machine mostly as you wish to have it. After having come to an understanding with the contractors as to what you are to do and settled all minor questions as completely as possible, you will first obtain a suitable crew of men. A proper selection is absolutely necessary. They must be cool-headed, fearless fellows, and it is particularly desirable that they be not afraid of steam, so long as it does not reach them. I have found some trouble in obtaining suitable men for this kind of work, but the preliminary trial often proves them and they go away.

"Now we are supposed to have got aboard the cruiser with assistant engineers, oilers, water tenders and firemen in numbers sufficient to run the machinery for four hours, and then the training begins. The engines and all auxiliary engines and boilers are now supposed to be complete with every appliance in place, oil service and water service ready to receive the oil and water. All instruments are up ready to be used to take data of the performance of different factors that are to combine to obtain an intelligent knowledge of the trial, from which a proper report can be made. First a proper and thorough examination of all parts of the boilers and engines must be made. The grate surface is to be measured correctly, as well as the air opening in grate, area of opening into the combustion chambers, area of opening through tubes, area of opening out of uptakes and area of smoke stacks, and the bracing of boilers and position of valves and pipes entering and leaving the boilers must have careful attention. The dry pipes are very important factors and require the closest kind of examination, for it is important that the steam be dry, and with this these pipes have much to do. The separators must have a proper examination, and the steam traps attached to them must be in the best of order and should be of the best kind. The engines, too, are being carefully examined. All bearings are taken apart, cleaned, adjusted and oiled; cylinders are opened and carefully examined, and pistons and their packings are looked over carefully. Valves are taken out, measured, taken apart and cleaned, put back, and careful readings taken of their functions. All piping has to be carefully looked over to see that it is properly run, and that it is provided with slip joints wherever it is necessary, and that it is so run that it will not be subjected to any undue strain, from any cause that in any way probable might occur.

"All the leading men must make themselves perfectly familiar with all valves about the engine and boilers, and this is not a very small matter, for the number is large, and although they are all marked, time is required to learn them thoroughly and it is important that the right valve is handled at the right time. Having done with the examination, we will proceed to fill the boilers with water. When full we will warm them by starting some fire. Then the testing is to be done. I usually test to at least 50 per cent. more pressure than what I intend to use on the trial. The safety valves are now adjusted to retain a pressure about 20 pounds greater than I wish to use on the trials. All this work, bear in mind, is to be carefully done, for the success of the trial depends very much upon how thorough you have been in getting ready, and it is always well to keep in mind that it is a very small thing that may stop the trial and add to the general cost of getting the cruiser to the final stage of completion.

"We are now far enough advanced to get steam on the boilers and to commence to run the engines. The fires are lighted and allowed to burn slowly, in order that the expansion to the boilers and pipes may be as even as possible. If we have a small boiler, we use it to run pumps for the purpose of circulating the water in the boilers, which is a very good way to overcome the evil effects of unequal expansion. When steam is made of sufficient pressure, the circulating and air pumps are started, the vacuum is obtained and then the main engines are warmed up in a careful manner and started slowly. The cruiser is securely fastened, usually to a wharf.

"The running of the engines continues day and night, one side at a time. Any work that is required is attended to on the off days for each engine. This is

* An address to engineers of Cleveland.—*Marine Review.*

kept up until the wearing surfaces are well smoothed and the adjustment of valves has been perfected. During this time the boilers have all been used with forced draught, but only a part of them at a time. The blowers have been tested and all defects have been attended to. Air pressure, which is an important factor, has been watched very closely. The men have been properly drilled and taught to know and to do their respective parts. This usually requires about three or four weeks' time, and during that time it has been learned very nearly how much coal can be consumed to the square foot of grate and how many cubic feet of steam it will make, and also how much water can be evaporated. The best point of cut-off is established and the piston valves are altered to suit that when in full gear. This applies to the high pressure valves particularly.

"Having done so much, we may consider that it is now time to take the cruiser away for a preliminary trial. This is done to establish the pitch of the screws, and also to have all of the boilers at work at the same time with forced draught on and with the engines working at full power. This gives the men a chance to understand more fully all that is to be done when the official trial comes. After a short run the cruiser returns to the place where the docking is to be done, and is placed in dock. The bottom is cleaned and prepared for the trial and the screws receive proper attention. When this is over with, the ship is sometimes taken for another preliminary spin, and if the results are satisfactory, the contractor gives notice to the Secretary of the Navy that all is ready for trial. The trial board is then ordered to proceed to the proper place and go on with the trial as instructed by the Secretary of the Navy, a copy of whose instructions are sent to the contractor, informing him as to when and where the trial is to be made. A few days are usually allowed in which to get the cruiser ready. This getting ready consists in loading the ship to the proper draught specified in the contract, putting stores and men on board, coal in the bunkers, and a sufficient quantity of selected coal weighed and put into bags to make the trial. This coal is so placed that it can be conveniently got into the fires. The cruiser is then steamed to the harbor most convenient to the place of trial, and usually one day is aken in further preparation.

"We are now at our place ready for the orders to go on the trial in the morning. A consultation regarding plans of management is held between captain, pilot and chief engineer. Matters must be so arranged that all will move in perfect harmony. The time of starting and a signal to inform the engineer that the trial is finished are agreed upon between them only. With the representatives of the government aboard, the cruiser weighs anchor and with new fires and a low pressure of steam starts for the course, which it is preferable to have about one hour at half speed away. The start is made to reach the course at the appointed time, so that there shall be no delay. The forced draught is started as soon as cruiser is well under way, moderately at first. The firing is now kept up at very short intervals until the furnaces are well filled with fire. Nothing but the lump coal is used, and that is the best that can be obtained. When you consider that from 40 to 50 pounds of coal are consumed on a square foot of grate per hour, you will conclude that some work has to be done. It is simply driving to get all the steam you can, which means burn all the coal possible. But while this is going on it is necessary that there shall be no excitement. No loud talking can be allowed—all orders are given by signs or by the use of bells. The men have been thoroughly drilled and know what to do. In case of anything happening, and it is a matter that can be righted, it is done quickly. The men who have been selected for firing are at work with a will. The extra watch is employed to handle the dampers in the air ducts and to open and close the furnace doors. All has been timed so that about ten minutes before the first line of the starting point of the course is reached the cruiser is going at the top of her speed. Members of the trial board are at their respective stations. All of their arrangements have been made the day before, and since the start they have been getting their instruments in their places and at a signal from the deck the engineers begin their separate duties, noting steam pressure, vacuum, reading of revolution counters, revolutions of blowers, air pressure in air ducts, ash pans, uptakes; temperatures of steam, temperature of engine room, fire room, feed water, condensing water, speed of all auxiliary machinery, indicator, pumps both steam and water ends. This is done each fifteen minutes during the trial. The number of engineers for the government on these trials is from twelve to twenty. The steam must be kept steady and the fires burning. No cold air must be allowed to enter the furnace. It is kept out by keeping the blast on strong enough to fill the furnace with gas and flame. The boilers were filled with water as high as they could be with safety on the start. A tank of fresh water placed on the deck has a steam pipe leading into it, and a pipe to draw the water down into the feed water tank when required to replenish the boilers. The steam has been turned into the tank and the water heated to the boiling point. This water is wanted usually during the last hour. Then, too, the steam is wanted in the engines. If all has been rightly planned, and you can make the last of the four hours equal to the first, then you have done well.

"When the last hour is reached, all begin to count the minutes, and when the last line has been crossed every one down in the engine room is very much pleased, and in the fire room much more so if possible. If all has been carried out without a hitch or break, smiles are on all faces and congratulations are in order, but the reverse is the case in event of failure. As I have tried to show you that very much depends upon the thoroughness of preparation and the selection of the right men for these trials, in which a performance out of the usual course of engineering is expected, you will readily see that it would not be doing justice to the men engaged in the work to say that it is all play, but so far as I know all of those who go through it like it and will leave almost any place to repeat their experience."

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A GENTLEMAN died suddenly in Paris, when it was found that his heart and liver and other organs were on the wrong side. He, however, lived to be eighty-five years old.

## SOME ELECTRICAL PHENOMENA.

IN spite of the teaching of school boards and of the utterances of the practical man, there still remains a marvelous charm in the pursuit of that kind of knowledge often denominated useless. Possibly no knowledge is absolutely useless, but for the present many lines of research yield so small a harvest of results to which a commercial value can be assigned, that the gain they offer is infinitesimal compared with the labor they demand. As an example, we may quote astronomy. By the aid of its discoveries the mariner navigates the ocean and the explorer in foreign lands determines his positions. These are matters of great importance, certainly, but they are concerned only with the fringe of the subject. Years ago these operations could be performed with almost the same facility as to-day, and yet during that period many wonderful secrets have been wrested from the heavens. Much of the work has been done by men who followed other objects for a living, and who sought rest and recreation in intellectual problems of great complexity. Not only in astronomy, but also in other sciences and arts, are researches being continually carried on without thought or hope of reward. Men who spend laborious days in offices and works borrow hours from the night to engage in the pursuit of knowledge, finding it more absorbing than all the seductions of pleasure. In libraries whose volumes have been collected by painstaking care and some self-denial and in laboratories innocent of the glittering toys of the instrument maker, but filled with admirable home-made appliances, work is done that would fill volumes if properly recorded.

As an example of this class of investigators, we may cite Mr. James Wimshurst, whose name appears in every modern text book on static electricity. As many of our readers are aware, Mr. Wimshurst holds a prominent post in the consultative branch of the Marine Department of the Board of Trade, a position as far removed from electricity as can well be imagined. After days devoted to naval architecture, he seeks relaxation in other sciences, bringing to his subjects a wealth of ingenuity and handicraft skill which has made his workshop the resort of many of the leading scientific men of the day. Seldom a year passes that he does not evolve some brilliant experiment with which to dazzle the distinguished gatherings that assemble at Burlington House in May, each one being more beautiful than the last. For a long time he was unapproachable in his own province, but the lavish generosity with which he gave away the fruits of his experience has put into the hands of others the means to reproduce many of his effects. His influence machine marked an immense step in experimental research and furnished the means of generating static electricity at any time and in almost unlimited quantities. Before its introduction experiments with static charges could only be undertaken, "weather permitting," and generally failed before an audience. The labor and uncertainty attending them rendered them so difficult and laborious that they were not readily undertaken. Now the influence machine is as reliable as the common pump and responds to the first turn of the handle.

Hundreds, if not thousands of them, are in existence, scattered all over the world, and there is little prospect of their being superseded No one even thinks of attempting to improve them.

Mr. Wimshurst must have given away dozens of his machines, varying in size from the 7 ft. disks at South Kensington and the large multiple disk machine at the Royal Institution to little toys no larger than a crown piece. He is, further, always ready with advice and hints to other designers, even when they aim at surpassing his own efforts. In watching him perform his experiments, one gains the idea that they are absurdly easy and simple, but when the spectator endeavors to repeat them he soon finds that great skill and much experience are requisite for their accomplishment. Mr. Wimshurst's marvelous intuition in electrical matters is more misleading to the onlooker than the most carefully planned deception could be. Very slight variations of manipulation often make the difference between success and failure, and it has become second nature with him to choose the right course and avoid the wrong. It has ceased to be a matter of ratiocination, and is the unconscious expression of a thousand forgotten experiences which have moulded the action of his mind into singular conformity with the conditions under which he works. It is not that Mr. Wimshurst is not desirous that others should emulate his effects—on the contrary, no man is more devoid of jealousy or more anxious for the spread of knowledge—but that he is quite unable to realize how easy it is to go astray. We do not profess to explain in detail the mental process we are referring to, but it is one that most people are familiar with in art, if not in science.

A skillful pianist is unable to describe how his fingers thread their way among the notes and reproduce his improvisations, not only as regards the air, but also the harmonies; neither the actor nor the painter can reveal the secret of his art in its higher branches. All that can be written down and published in books is journeyman work; the action of the master mind is inscrutable.

We have seen experiments performed several times; sometimes in response to a chance request, and yet in less than five minutes the apparatus has been put together, and the operations have been in full swing, without a single word of explanation or apology for failure or shortcoming being necessary. We have also known able experimenters try to repeat them with their own apparatus, and find themselves in need of a second visit before even attaining a moderate degree of success.

One portion of a demonstration is most impressive. On a sheet of bronze paper there are placed two small Leyden jars, some 5 ft. or 6 ft. apart. Their insides are connected respectively to the positive and negative poles of a powerful Wimshurst influence machine, while their outsides are in contact with the paper, which is itself on an ordinary table not specially insulated. When the machine is worked, positive and negative charges are given to the two jars, while from the outsides flow charges of opposite name. As the table forms a very imperfect "earth," these latter charges get away with difficulty. The bronze paper, although looking very metallic, offers great resistance, as is shown by the sparks which traverse it. If the terminals of the machine are fairly close together, say 5 in. or 6 in. apart, the charge attains its full potential several times a second and discharges itself between these terminals. After each spark the outer charge on the jar has to get away, and it does so by throwing out brilliant green threads of flame in all directions. One could imagine that beneath the jar lay some fabled animal—a kind of tarantula—which, driven to bay, had taken refuge there and spat out burning venom in all directions. The energy and variety of the discharges are beyond description, and suggest, not the recurrent effect of a cause acting under constant conditions, but the fury and despair of a living being resolved to sell its life at the dearest price.

When the terminals of the generator are drawn wider apart, a fresh set of phenomena appears. The attraction between the charges in the two jars enables them to leap, or rather to skip, over the intervening 5 ft. This is not a clear jump through air, but a running passage over the feebly conducting paper, which offers, as it were, a series of stepping stones to bridge the wide space. At the same time the character of the discharge, both at the jars and the machine terminals, suddenly alters. It becomes brilliantly white, with a sudden snapping noise, the effect being trying both to the eyes and the ears. There is a thunderstorm in miniature, and not without some of its awe-inspiring effect.

The green radial lines, which still persist, but are almost lost in the fierce effulgence of the white discharges, have not impressed themselves on the photographic plate. The white sparks all seem to start from the jar connected to the positive pole of the machine—the left-hand jar—and to follow a devious course to the other jar, seeking the path of least resistance. Some of them turn in quite sharply at the last. It is a grand sight to watch the torrent of electricity leaping and skipping in its mad efforts to get from jar to jar, filling the room with light and noise and an overpowering smell of ozone.

Another is an example of a very different form that an electric discharge can take. Here the two terminals of the generator are faintly visible at each side, the positive (left) terminal being 2 in. in diameter and the negative 4¾ in. There is little evidence of the fierce disruptive energy depicted in the first experiment. It is true there is spitting—and very active spitting too—on the left side, but the sparks lose themselves in the palpitating violet haze that streams from the opposite terminal. The idea of energy is still impressed on the spectator, but it is of a different kind. Forceful and unceasing the brush pours across the intervening 14 in. to envelop and absorb the snapping sparks which seem powerless to make headway against its powerful stream. The effect is rendered more impressive by its silence.

Here we have another and very beautiful variety of electric discharge. Two tumblers 9 in. high by 4½ in. in diameter—goblets fit for Jupiter Tonans himself—serve as modified Leyden jars. On the inside they are coated with tinfoil to within 1 in. of the top, where there is a loose wooden cover dropped into each. On the outside there is a narrow strip of tinfoil at the base, the intervening space between its upper margin and the lip of the glass being coated with gum water in which a little bronze powder was mixed. The surface is thus rendered feebly conductive. The bases of the two tumblers are connected by a metal chain, which practically constitutes "earth." When the generator is rotated, these jars are charged until the potential exceeds the sparking distance between the terminals of the machine. But this distance represents a greater resistance than is offered by the bronzed surface of the glass, and hence the charge overflows every time.

From the inside coating a spark leaps from beneath the wooden cover, clears the inch or so of uncoated glass and then rushes down the outer surface. Seldom does it find the shortest way the easiest to follow. It comes over the edge of the tumbler vertically, but after that nothing further can be predicted as to its route. It may branch to right or left, or it may go straight. The one thing that it will not do is to follow the course of a predecessor. It must be remembered that these sparks occur singly and do not exercise any mutual repulsion. Yet they seem sedulously to avoid each others' paths; each one strikes out a line for itself, even if it have as its origin a point which has already seen the genesis of several preceding.

Quite a different result is gained if greater resistance is offered to the current. The jars are 16¼ in. high, and the surface above the bottom band of tinfoil is coated with shellac, without the addition of bronze powder. There is no path along which the discharge can rush in an impetuous stream of well-defined course. It can only escape by filling every available channel and flowing in innumerable rills. These give the impression of beautiful vegetation, stretching upward in golden fronds that are ever reaching toward the summit, and falling back to again commence their momentary growth. The intricacy and delicacy of the pattern are marvelous, suggesting the frost tracery on a window, depicted in threads of fire. But if the potential be pushed too far, the energy of the discharge will overleap the full length of the jar and the 2 in. clear zone within it, and will produce a flash of intense brilliancy.

The effect of the added potential is great. The sinuous playful character of the upper discharge is replaced by one of painful vehemence. Not only does it leap the wide distance, but its effulgence spreads through the entire thickness of the glass, while along its course it throws out fierce vengeful sparks, seemingly purposeless in direction. The tree-like growth is drained of its energy to supply this violent flow and becomes almost invisible.

What is the practical value of these brillant phenomena? Frankly, we know of none. The true lover of science does not ask such a question. He finds his reward in mastering such a wayward, erratic force as electricity and causing it to display its activity in many and varied forms. Every time he is able to evoke a new phenomenon his insight into the operation of nature is increased. His knowledge grows with each development, and the thirst for knowledge is an appetite that is increased by each attempt to appease it. Had it not been for this our race would still have been

enveloped in the obscurity of the dark ages, and we should have been shut up to material pursuits. The possessions which the world holds dearest are due to those who, in all times, have pursued useless knowledge.

The monks who copied the manuscripts of early times and so preserved them to posterity; the astrologers who observed the stars and left some record of their motions; the historians who collected traditions and legends; the painters and sculptors from whose works we learn the beauty of earlier peoples; all these followed pursuits of little or no practical value. Yet every atom of their work which has survived the ravages of time is immensely precious, and not only do its lessons become clearer, but it sheds light in unexpected ways on kindred subjects. So it is in science. Some day every fact will be found to have a niche in the great cosmos, and many that are now merely sources of intellectual pleasure will become of great material importance. Faraday's discoveries in electromagnetic induction were once regarded by the multitude as curious and strange, but of no practical value. Yet in comparatively few years there has been built upon them a new engineering industry, the result of which no one can venture to predict. The world is full of disconnected knowledge gathered without thought of reward by earnest students; but gradually the facts and partial theories are coalescing, and eventually will form an organized body that would be imperfect if any part were omitted.—*Engineering.*

## ABOUT CASTOREUM.

Of all the sudden fluctuations in the market position of drugs which we have lately recorded, the rapid advance in the price of castoreum during the past two or three years has been one of the most remarkable. There are not many pharmacists who ever get an opportunity of seeing the drug, or whose knowledge of it, in the natural state, goes farther than the statements in the text books, which tell them that castoreum is the secretion contained in the castor glands of the *Castor Fiber*, forming a waxy substance of extremely

CANADIAN CASTOREUM PODS.

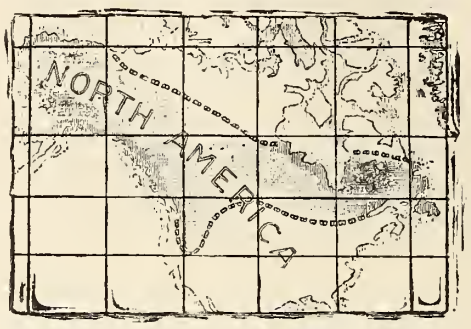
pungent odor, found in two large pockets placed near the base of the tail of the animal, enveloped in muscles specially fitted to enable the discharge of any portion at will, and which pockets are not connected with any other organ.

Piesse tells us that the odor of castoreum is developed in an extraordinary degree when the substance is infused in alcohol: 2 oz. of the drug in a gallon of spirit will make a standard extract, but if more than a quarter of a pint of the extract be added to a gallon of any other scent, the characteristic castoreum odor eclipses all the others.

At present the beaver is probably much more numerous in the Siberian than in the Canadian forest rivers, and he will probably survive in Asia long after his extermination on the American continent. But the habitable parts of Siberia are also gradually being brought under cultivation, and where the engineer and farmer penetrate, thence the beaver disappears. At present our market supply of castoreum still comes mainly from Canada. The Canadian article has risen in price tremendously during the last few years, and it now realizes nearly five times as much as in 1886.

Statistics show that the rise in price of castoreum has altogether outrun the dimensions warranted by the diminution of the supply, and from these circumstances it may be inferred that beaver hunting will receive fresh encouragement, and that—for a period, at any rate—castoreum will become once more sufficiently plentiful to allow of a considerable reduction in price. But it is not so certain that this will be the case, inasmuch as nearly the whole of the business is in the hands of one large trading concern, the Hudson's Bay Company, whose interest lies in the preservation of the high prices now ruling, and who will probably see to it that the market is fed sparingly. The company have long been in the habit of holding two auctions every year; the principal one about the middle of December and a smaller one in the spring. Most of the castoreum offered at these sales is bought for export to the Continent and India, for although, as our correspondence columns of the last few weeks have shown, the drug is still occasionally prescribed in this country, the consumption here is of no account compared to that in France, as an ingredient in perfume manufacture, and in other countries as a medicine.

Singularly enough the price of Siberian castoreum has declined almost in the same proportion as that of the Canadian article has risen. About twenty-five years ago Siberian castoreum, then of extreme scarcity, is said to have realized as much as £22 per lb. in the European markets; in 1891 it might be had for a tenth of that price; but since then it has again doubled in value. It was formerly official in the German Pharmacopœia. In 1878 and 1879 castoreum from beavers




DISTRIBUTION OF THE BEAVER IN 1850.

caught in the Elbe and other German rivers was still offered in the market. The quality, however, was not much liked, and the drug does not appear to have been offered in quantities of sufficient importance to make it a commercial article. In value it ranged about midway between Canadian and Siberian castoreum.

A representative of *The Chemist and Druggist*, anxious to find out something about that part of the trade in castoreum which ends with the selling of the drug at the London auctions, called for that purpose upon Mr. W. Halsey, the Hudson's Bay Company's broker, at the old house of the company in Lime Street.

Mr. Halsey was busily engaged sorting skins, still, as ever, the principal article of trade of this company. During the winter time every minute of daylight is valuable to a skin valuer, for the goods cannot be properly judged by artificial light, and the aggregate yield of a Hudson's Bay sale runs into thousands of pounds. On January 15, for instance, Mr. Halsey's auction catalogue included 46,412 beaver, 648,687 musquash, and 58,154 American rabbit skins, not to mention 11,799 salted and 353 dressed fur seal hides.

"Now, sir," said Mr. Halsey, when the gray twilight began to descend upon Lime Street and soften the severe contours of its brick walls, "I am at your disposal." And with that he divested himself of his cotton overalls and turned up a book of prices realized at auctions. "You want to know about castoreum, isn't it?"

Our representative assented, and thinking that he might as well go to the heart of the matter at once, asked: "Where do you get your supplies from at the present time?"

"Well," said Mr. Halsey, "I don't know that it would be wise to answer that question right off. As you probably know, our castoreum bears different marks, which roughly indicate the districts it comes from. Thus YF stands for Fort York, here, about halfway up the west coast of Hudson's Bay. All the castoreum that comes in from the region north of Canada proper and east of the Rockies is brought into trade by way of Fort York." And Mr. Halsey's hand covered a district on the map measuring so many hundreds of thousands of square miles that any fear of a competitor acquiring valuable information from the Fort York tip may be dismissed as groundless. "Then there is MR (Moose River, a fort of ours at the mouth of the river of the same name, at the southernmost end of the bay). Castoreum so marked comes mostly from the Moose River district—partly also from Western Canada. The 'Canada' mark indicates the produce of Eastern or Lower Canada, and by N.W. (northwest) we understand everything produced west of the Rocky Mountains. These are the four great geographical divisions of the drug."

"As to prices?"

"The price has risen enormously lately, as you know, and I am convinced that the rapid diminution of the supply is a partial explanation of that fact. The beaver's days are numbered. He cannot co-exist with civilization. Until the last few years we imported 100,000 skins a year on an average. This year we have barely received 60,000, and the prospects for the future are still worse. Our castoreum auctions, too, have declined from an average of about 2,500 lb. per annum about ten years ago to barely 1,300 lb. now."

"Then you look forward to the time when a castoreum pod will be as scarce as a great auk's egg?"

"I am afraid that will be the end of it. The beaver

THE HUDSON'S BAY COMPANY'S BEAVER TOKEN.

cannot be domesticated. All attempts to rear him in captivity have failed."

"Your last small December sale does not represent the whole quantity you intend to offer this season, I presume?"

"We shall have a small sale of N.W. castoreum in March or April, but it will not exceed a few hundred pounds. It takes some time longer for this brand to reach here than it does for the others. As the bulk of our castoreum is here in December, we always have a sale in that month, and what little comes afterward is sold in the spring or early summer. At one time our company were the only importers of castoreum," said Mr. Halsey, "but now there are others in the field. One firm import from the United States, and I believe that some castoreum also comes from Alaska. It is cured quite differently to ours."

"I should like to hear something about the preparation of the drug."

"I regret I cannot enlighten you about that," came the answer. "The Indians who trap the beaver bring the skins and castor pods to our forts and exchange them for provisions and clothing. They are very clever at adulterating the pods, filling them with rubbish, and closing them up again so that it is difficult to detect the fraud, and our officers require to be very careful. The castoreum is generally somewhat wet when it arrives here, and it is graded into 'firsts,' 'seconds,' 'thirds,' and 'pickings,' according to its quality. When skins were more plentiful than they are now, and castoreum was worth only about 15s. per lb. or so, we thought very little of it as a branch of our trade, but nowadays it is an item of fair importance in our business.

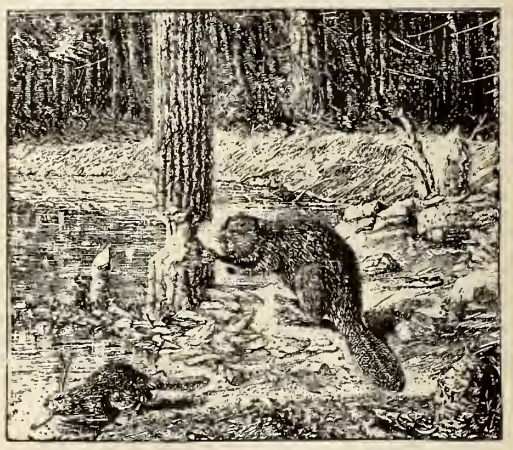
"See here," continued Mr. Halsey, turning over the pages of his salesbooks. "The lowest price on record is 7s. per lb., and from 1881 onward the average price of our consignments has steadily risen from 21s. up to 104s. per lb., and the quantity offered for sale has diminished by one-half."

"But if you ground your reason for an advance entirely upon the increasing scarcity of the drug, how do you explain that the value has multiplied by five while the supply has only fallen off one-half?"

"Probably the use of castoreum in medicine is increasing, and the substance is one of those, you must remember, for which there is no substitute. To the medical man or perfumer the price is a matter of secondary importance."

With this our representative took his leave, to devote himself to the historical side of this interesting subject.

In 1536, when Jacques Cartier, the first European who trod Canadian soil, landed upon the shore of the St. Lawrence River, the beaver was distributed over a larger area than any other animal in North America. Its habitat ranged from the Mexican Gulf to the Arctic Ocean and from Alaska to Florida. On vast tracks of prairie land, within these boundaries, it was, of course, unknown, but along the great rivers the rodent overran the country. It was hunted by the Indians chiefly for the sake of its fur, its flesh, its castoreum and the supposed curative properties of its fat, but the natural increase of the animal must have



THE BEAVER AT HOME.

greatly exceeded the numbers slain to furnish raiment to the redskin.

With the advent of the white man the beaver's period of tribulation commenced. To the unsophisticated mind of the redskin a piece of scarlet cloth, a string of beads or a musket was a possession acquired absurdly cheap at the cost of many beaver skins, and beaver hunting at once became a profession, followed with all the enthusiasm that the hope of acquiring some of the white man's trinkets could inspire. The medicinal virtues of castoreum and other parts of the animal soon became famous in Europe, although a century and a half, in the course of which many millions of beavers had been sacrificed upon the altar of commerce, elapsed between the discovery of Canada and the publication of the first European treatise devoted to the medicinal virtues of castoreum. That treatise, published in the year 1685, was the work of one Joannes Franco. It bore the following lengthy explanatory title: "'Castorologia,' explicans castoris animalis naturam et usum medico-chemicum, antidhæ (?) à Joanne Mario, Bollensi et Physico Ulmano postea augustano celeberrimo labori insolito subjecta. Jam vero ejusdem auctoris et aliorum Medicorum observationibus luculentis ineditis, adfectibus omissis, et propria experientia parili labore aucta à Joanne Franco."

According to the author there were few parts of the beaver that were not medicinally valuable. Indeed, he avers that the beaver was hunted for "its skin, its fat, its blood, its hair, its teeth, and especially for its pockets or tumors, which are placed in the groins." The skin is alleged to cure bed sores and consumption in children, and to be eminently useful in "colic, madness and spasms." The beaver fat is an excellent cure for affection of the nerves, epilepsy, apoplexy, toothache, asthma, dysentery and strains. The blood was also given as a remedy for epilepsy, the hair was recommended as a styptic. Beaver teeth tied round the necks of infants were esteemed excellent in promoting the cutting of the teeth; powdered, they were given in soup to epileptic children. The author of the treatise mentions a number of cures effected by him in cases of sciatica, "loss of memory," pleurisy, and so on.

"The doctors of Augsburg," continues this writer, "have introduced castoreum into thirty of the best compositions of the Pharmacopœia. It destroys fleas; is an excellent stomachic, stops hiccough, induces sleep,

strengthens the sight, is used as an antidote to the sting of scorpions, spiders and the tarantula, the bad effects of opium (*sic*), and even against the pestilence." In this style the learned author meanders on through pretty nearly all the complaints known to the faculty, winding up with a eulogy of the drug as a "proved remedy for earache, and not less efficacious in deafness."

Probably castoreum was low in price at the time. There is no particular reason why it should have been otherwise, for hunting went on merrily (from the huntsman's point of view) all through the seventeenth and eighteenth centuries. We have no means of tracing the market value of the drug when "Castorologia" was issued, but in the price list of 1756, which we reproduced in *fac-simile* some years ago, we find "Castor, Hudson's Bay," quoted at from 8*s.* to 9*s.* 6*d.*, "Castor, New England," at from 7*s.* to 7*s.* 6*d.*, and "Castor, Russia," at 36*s.* per lb. It is curious to observe how from the earliest times on record until quite recently, Russian and Siberian castoreum has been held in higher esteem than the American drug.

But let us return for a moment to the history of the persecution and extermination of the beaver. Ten years before Jacques Cartier descended upon Canada, the beaver breathed his last in the British Isles, but so late as 1714, when the Canadian beaver skin trade had been in full swing for generations, numerous colonies of the European beaver were still found along the River Elbe, where they were protected from extermination by law. The first Canadian fur-trading post was established in 1604, and from that time onward until within the memory of the present generation the unfortunate rodent was the prop of British North American trade.

Attacked from the North by the agents of the "Company of Adventurers Trading into Hudson's Bay," by the Dutch, and later on the British, from the New England side, by the French from the St. Lawrence, and by the Indians from all parts, the beaver quickly disappeared from all its haunts accessible to man.

In 1733 the Hudson's Bay Company exported annually about 15,000 beaver coats and 175,000 skins, while the French company of Canada, in 1715, sent to Europe about 100,000 skins, and 80,000 more came into trade *via* New York. Beaver skins were the standard of value of all goods traded with the Indians, and from an "Account of the Countries Adjoining to Hudson's Bay," published in 1774 by Arthur Dobbs, we find that in that time three marten skins, one wolf skin, or 1 lb. of castoreum were reckoned as the equivalent of one beaver skin. On the other hand, the Indian had his choice, from among other commodities, of one dozen needles, one checked shirt, 1½ lb. of gunpowder, or a dozen buttons in return for such skin. In such trading matters, the "giving too little and asking too much" was not confined to one particular European nation.

In 1821 the Northwest Company of Canada was incorporated into the Hudson's Bay Company, and shortly afterward measures were devised for putting an end to the reckless extermination of the beaver. A still greater piece of luck befell the wretched animal a few years later, when the adoption of silk to the hat-making industry sealed the doom of the heavy beaver hat, which had flourished so long as the Moloch to which millions of the rodents had been sacrificed. But for this invention the beaver would now probably have been as extinct as the bison, for early in the century matters were already rapidly tending that way. In 1814, as far in the interior as the Mackenzie River, the Indians complained of the want of beaver, and presently all the posts in that district were closed for that reason alone. Immediately after the rise of the silk hat, however, the beaver began to show a noticeable increase in many parts of Canada, and for many years, in fact, until well into the sixties, it must have seemed to the animal as if the old Indian days were returning. Railways and immigration, however, have since had their effect upon the beaver and elbowed it out of all the cultivated districts.

The map here reproduced, which is taken, with our other illustrations, from another book called "Castorologia," published a couple of years ago, shows the distribution of the beaver about the year 1850. According to it, the animal at that time had disappeared south of the St. Lawrence and had lost its hold upon the United States, all but a small section in the extreme Northwest. Major W. Ross King, in his book "The Sportsman and Naturalist in Canada," states that "at the present time (1866) the beaver is found on lagoons and streams in the country about Lake Superior and the Roseau River. Eastward it is tolerably plentiful on many of the small tributaries of the Restigouche, and in the more remote regions of British North America is abundant;" and Mr. Horace T. Martin, a Canadian author, writing in 1892, observes: "Some colonies still linger in the United States, on the slopes of the Rocky Mountains, and are sparsely scattered over the continent; but along the watershed between the Hudson's Bay and the St. Lawrence, in the upper waters of the Frazer and Peace Rivers, and along the (Canadian) Rocky Mountain range may be considered the last homes of the beaver."

The possession of castoreum pouches has been a fatal gift to the beaver. Until the end of the last century the Indians were restricted to few and comparatively clumsy methods in hunting the animal, but at that time the natives of New Brunswick and of certain portions of Canada, observing the success of the white man in catching fur-bearing animals with a steel trap, turned their attention to the possibility of adopting this means to augment their store of beaver skins. The one difficulty in the way was that no bait was known sufficiently attractive to allure the beaver to it in preference to the vegetable foods in its haunts [it lives mainly upon the rhizome of the large yellow pond lily (*Nuphar luteum*)]. Mixtures of various drugs, foods and herbs were tried in vain for a long time, until at last some one hit upon the idea of baiting a trap with castoreum, the beaver's own secretion The effect was marvelous. The beavers rushed to the castoreum baited traps, like Indians to whisky, as if impelled by an irresistible force. As Mr. David Thompson, a careful observer of life in the Canadian backwoods at the end of the last century, puts it, "the secret of the bait was soon spread. Every Indian procured from the trader from four to six steel traps (weighing from 6 to 8 lb. each), and all labor was at an end: the hunter moved about at pleasure with his traps and infallible castor bait." Mr. Thompson saw several instances of the infatuation of the beaver for castoreum.

Sometimes beavers escaped from castor-baited traps with the loss of limb, but they would invariably return to their doom within a couple of nights. The castoreum stick was always licked clean, and the substance seemed to act upon the animal like a soporific. When the Nepissing, Algonquin and Iroquois Indians had exhausted their own districts they followed the retreating beaver northward and westward. For a while the Indians reveled in gin, beads and scarlet cloth, and the traders' canoes carried such loads marketward that beaver products became almost unsalable in the London market. But within four years of the introduction of castor bait the whole country of the three tribes mentioned was beaverless, and the Indians fell into a state of helpless poverty. The profits to the white trader on the sale of beaver skins at the commencement of that period are said to have averaged 2,000 per cent.

The castor trap has never been superseded, and to this day every trapper carries among the impedimenta of his craft a bottle of "medicine," consisting of a vegetable extract of some kind flavored with castoreum. The castor used for trapping is not smoked and cured like that seen in the London market, but consists of the fresh, oily substance. It is also employed now for trapping lynxes and other valuable fur-bearing animals, for which the secretion possesses a fascination second only to that which it exercises upon its own producer.

Among the Indians castoreum has been held in therapeutic repute from time immemorial, and they also use it to flavor the bark mixture which they are in the habit of smoking when tobacco is scarce.

The Hudson's Bay Company are now doing all in their power to prevent the total extermination of the beaver. They have systematically set aside certain islands, particularly favored by the animals, along the coast of Hudson's Bay, as beaver reserves. These islands are visited every third year (which is the period in which a beaver kitten matures), when as many animals are killed as are calculated to represent the natural increase during that period. But within a few years the beavers will have destroyed all the trees in the islands, and then, unless new preserves are started, the animal will probably be within measurable distance of extermination. Proposals for the establishment of beaver ranches, however, are constantly being mooted in the Canadian press. In certain parts of the Canadian Rockies, where colonization is now taking place, the beaver colonies are said to be protected expressly in order to preserve the water supply, for experience has shown that in many parts of British America the extermination of the beaver has been followed quickly by severe droughts.

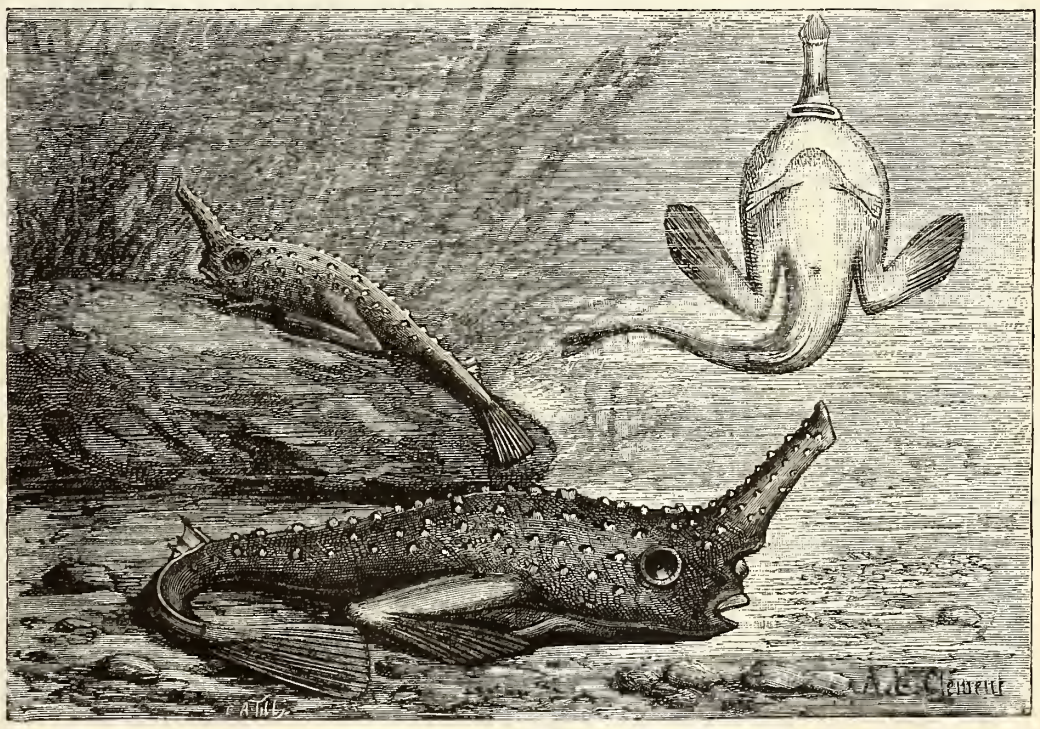
The beaver is the national emblem of Canada. It appears upon the arms of that country from the times of its first settlement. Its name survives in scores of Canadian rivers, settlements and miscellaneous landmarks. It has a place, as philatelists well know, in the postage stamps of the Dominion. "Beaver tokens" were issued at one time by the Hudson's Bay and Canadian Northwest Companies as tallies for skins bartered from the Indians. They are now among the rarest of numismatic curiosities. That which we here reproduce in *fac-simile* was struck in 1854 or 1855 at the suggestion of Mr. McTavish, then in charge of the Albany Fort of the company. It bears the coat of arms of that corporation: a shield quartered, with a beaver in each quarter, a fox for the crest, two stags as supporters, and the motto, "Pro Pelle Cutem" ("The skin for the fur"). The legend on the reverse consists of the initials of the company, and letters E. M. for East Main, the district in which the tokens circulated. The "½" stands for the value = half a beaver skin; there were also eighths, quarters and full units, and the N. B. is a mistake for MB = "made beaver," signifying the flawless skin of an adult specimen. The last of *Castor Canadensis* has long gone to Great Manitou's happy hunting grounds, and he has been followed in due course by the last of the bisons. And as a companion of these great figures in the story of the North there will appear, at no very distant date, the ghost of the last of the wild beavers.

## THE WALKING FISH.

FISH, as every one knows, have their organs adapted for swimming, so that they exhibit arrangements very unfavorable for any other kind of locomotion. However, a few most interesting exceptions are observed. Certain types find themselves forced, either by surrounding circumstances or for seeking food, to leave the water for a certain length of time. Thus the flying fish is adapted both for flying and swimming, and there are others that are truly walkers. We may mention the *Maltha*, a Brazilian fish, which most certainly attains the highest degree of differentiation in this direction. We have had a specimen of it in our hands which came from Bahia, and we profit by it to call attention to the most curious peculiarities that it exhibits. In the accompanying engraving one of the figures gives a view of the ventral side and the other a profile view, both reduced about one-third.

It is a fish which cannot swim, but is forced by its very organization to walk, or, perhaps, to hop after the manner of toads, of which it has vaguely the external form. The head, which is very large, is provided at its anterior part with a bony spine, at the base of which are situated the nasal apertures. The bronchial orifices are small apertures situated wholly in the dorsal surface, as in the Callionymes, so that the water can remain for a long time in the bronchial chambers—a circumstance very favorable for species so frequently at a distance from water. The entire body, save the ventral wall and the tail, is covered with bony plates forming a very ornamental cuirass. Behind the hind members the body tapers considerably, so as to resemble a tail terminating in a fleshy fin. Upon the dorsal crest there are observed three or four little spines, the remains of the dorsal fin.

The locomotive organs exhibit truly interesting arrangements. The anterior (the pectoral fins), which are quite small, and are situated under the belly, have truly the form of small thin paws terminating in a widened fleshy portion not at all palmate. Here we have already well modified fins; they are no longer capable of acting on the water, and must perform nothing but backward and forward motions. But the posterior organs (the ventral fins) are still further transformed. They stand out laterally, and first turn downward and then bend upward and outwardly, forming a true articulation. They terminate in a wide and fleshy paddle.



THE WALKING FISH (*Maltha vespertilio*).

These are very different from the same fins in other fishes. We have here the formation of a true limb, that naturally cannot serve for swimming, but only for walking, after the manner of toads, which move scarcely anything but the foot and leg, the thigh remaining closely applied to the body and nearly motionless.

Finally, one peculiarity which well shows that the animal is destined for crawling is the form of the anal fin, which, instead of being protuberant and flattened laterally, is here adherent to the tail and flattened vertically, so as to resemble a small elongated and concave blade. This is, we believe, one of the rare examples of the adaptation of the anal fin.

We may clearly see that all the arrangements conspire to the same end, *i. e.*, to prepare organs primitively adapted to swimming for a very different function. The differentiation does not attain a very high degree, but it is clearly indicated. It would be very interesting to examine these paws from the standpoint of osteology. Perhaps a new fact might be added to that so much discussed question of the homology of the organs of fishes with those of the higher vertebrates.—*La Nature.*

## NOTES ON FISHES.

IN Florida, there are numbers of ponds all isolated from each other, and varying greatly in size. These ponds may be mere hollows, without any perceptible source of water supply. Others, again, are placed at high levels—a fact which removes any idea of their owing their existence to overflows or floods from other sources. Now, all these Floridan ponds swarm with fishes, and the question arises, whence do they derive their living tenants? In the warm season the smaller ponds become dried up; yet on being refilled, from whatever source, their fish tenants appear to be as plentiful as before. In one case a pond situated at a

very high elevation contained an abundant fish population. A writer tells us be has twice noticed this pond to be dried up; yet, after refilling, its fishes were as numerous as of yore. Perhaps the explanation may be found to rest on the fact of the fishes having acquired a power of resisting dryness of their surroundings. The mud fishes (*lepidosiren*) are able to live packed in dry mud; but then they possess lungs in addition to gills, and are thus direct air breathers during the dry season. The Florida fish ponds would appear at least to offer a very interesting problem for local zoologists, and one may hope to hear of a solution of the facts being forthcoming at no distant date.

The case of the Florida fishes reminds me that in 1803 Von Humboldt saw a volcanic eruption at Cotopaxi, in the Northern Andes. From the crater were ejected large numbers of fishes. Humboldt's observations were received with surprise and incredulity; but they have been fully confirmed by later observers. In other volcanic peaks of the Andes range the ejection of fishes has been observed. They have been thrown to a height of 16,000 feet above the sea level, and half that height above the plains below the mountains. The species of fish has been named the *Argas Cyclopum*, and it appears to be the only kind which is ejected from the craters. The fishes appear occasionally to be thrown out in such numbers that the decay of their bodies produces noisome exhalations in the adjacent territory. The clew to this mystery may be found, perchance, in the fact that the Argas fish live in lakes in the vicinity of the volcanoes. Now, as volcanic eruptions are associated with water, and as that water, gaining admittance to the earth's heated interior, is converted into steam—a volcanic eruption being merely a kind of cosmical steam explosion—it does not seem at all improbable that the fishes are swept into the line of volcanic action from the lakes, and simply expelled, after a hurried subterranean journey, from the volcanic crater. If this speculation should prove to be correct, it will only tend to show, once again, that truth is stranger than fiction. We have heard a good deal of late years in novels about mystic subterranean journeys and underground expeditions; and our fishes may lay claim, perchance, to all the distinction which attaches to such marvelous explorations.

The fecundity of fishes is proverbial. The latest account I have seen of this property of the finny tribes is that of the number of eggs in an eel weighing six pounds, which is set down at nine millions. I fancy the cod and herring are not far behind the eel in respect of their fertility. Nature is ever prolific, but is sadly handicapped by the tremendous waste of her materials which everywhere occurs. Thousands and thousands of fish eggs come to nothing, of course. Many are devoured; still more are simply killed by cold. Little wonder, however, that naturalists should calculate that unchecked development of such a host of eggs as the eel possesses would in a few years fill every ocean with a solid mass of fishes.—*Andrew Wilson, in Illustrated London News.*

## THE DEVELOPMENT OF THE CHICK.*

Charles Bonnet, the distinguished naturalist, was born in Geneva in 1720 and died in 1793. He worked assiduously with microscope and lens and devised many new experiments on plants and animals. He was a friend of Haller's and stoutly maintained the latter's doctrine that all the vital functions could be reduced to two—sensibility and irritability. His first important work was the investigation of the life history of aphides, and his interpretation of parthenogenesis was a great triumph to the *ovists*. The process of development in his time was considered by many to be purely a process of unfolding of a preformed germ which contained in miniature the future animal or plant. But the supporters of his idea were divided into two camps; the *animalculists* held that the miniature animal—the germ—was carried in the male seminal fluid to the proper matrix, where it found suitable nourishment and grew—*i. e.*, unfolded. The *ovists*, on the other hand, maintained that the germ existed in female, and explained fecundation as a stimulus produced by the male fluid, which furnished the first nourishment of the tiny germ. The fact, then, that a female aphide could produce offspring without coupling with a male seemed to give the ovists a convincing argument.

His works are interesting reading to-day, for he was not only a keen observer but a careful writer as well. To be sure his facts are often meager, and often the results of his or his contemporaries' observations were insufficient to base the broad generalities upon in which he delighted; yet within the knowledge that he had he argued well. Who knows but what the student of a hundred years hence may smile at Weissman's conclusions as we do at Bonnet's? In the following description of the development of the chick the reader should always keep this in mind and should as far as possible forget for the time much of the detail that has become known to us since improved microscopes and sections have been in use. The selection translated below may be found in his "Contemplation de la Nature" (tome iv., pt. 1, chap. x.), published in 1764:

### LA GENERATION—LE POULET.

An egg not fecund has a yolk like an unfecund egg. The goodwives have known this all the time; and there is in this little fact, so well known, so little examined and so worthy of it, something which comes to throw a flood of light and has cleared away the shadows with which the great mystery of generation has been enveloped.

Give all your attention to this: you are going to put your finger on an important verity. A membrane invests the yolk internally, and this membrane, which is only the continuation of that which covers the small intestine of the chick, is common to the stomach, the pharynx, the mouth, to the skin and epidermis. Another membrane invests the yolk externally, and this membrane is only the continuation of that which covers the intestine: this unites with the mesentery and peritoneum. The arteries and veins which course through the yolk derive their origin from the mesenteric arteries and veins of the embryo. The blood which circulates in the yolk receives from the heart the impulse of its motion.

The yolk is, then, essentially, an appendage of the intestine of the embryo, and together they form an organic whole. Therefore, in earliest times, the chick is, to some degree, an animal with two bodies: the head, trunk and the extremities compose one of these bodies; the intestines and the yolk form the other. At the end of incubation the second body is pushed within the first, and the two make but the one.

But since the yolk exists in eggs which have not been fecundated, it follows necessarily that the germ is preexistent to fecundation. This consequence stares one in the eyes: you come to see that the yolk is an essential part of the chick. You recognize the direct connection between the one and the other. The chick has not existed, then, without it. The membranes and vessels of it are only a continuation of those of itself. And how many other things there are which they have in common, which prove that they have never existed separately. The chick was, then, entirely in the egg before the fecundation. Then it owes not its origin to the liquor which the cock furnishes: it was defined *en petite* in the egg, prior to the commerce of the sexes. The germ, therefore, pertains exclusively to the female.

The evolution or development proceeds by nutrition; you have seen it. Nutrition supposes circulation; you have seen it also. Finally you have seen that the heart is the seat of circulation. If it does make a circulation in the germ before fecundation, you will admit at least that it is not sufficient to perform the whole evolution which will render the germ visible, and which gives to all its parts the form, proportions, and arrangements which characterize the species.

The germ cannot achieve its development in an egg which has not been fecundated, and incubation will only hasten its corruption. Yet what does it lack in order to continue to grow? It has all the organs necessary to evolution. It has taken on itself a certain increase, for eggs increase in virgin pullets; their ovaries contain them in various sizes. The germ may grow, then. Why can it not develop completely? What secret force holds it back in the limits of invisibility?

Growth depends upon the impulse of the heart. A great growth depends upon a great impulse. The heart of the germ which is not fecundated lacks this impulse.

This demonstrates a certain resistance in the parts of the germ. In measure as it grows, this resistance increases. Some parts resist more than others; the osseous parts more than the membraneous.

The heart of the germ, then, needs a force proportioned to overcome this resistance. Its force is in its *irritability*, or in the power to contract when brought into contact with a liquid. Augment this irritability, and you augment its impulsive force.

Fecundation increases, without doubt, this force, and it alone can do that: since it is only by its intervention that the germ succeeds in freeing itself from the narrow limits which restrained it in its first stage.

The fecundating liquor is, then, a true stimulant, which, carried to the heart of the germ, excites it powerfully and communicates to it a new activity. This is what we call *conception*. Movement once impressed on this little prime mover is conserved by the unique energy of its admirable mechanism.

But it does not suffice that the heart acquire a force capable of overcoming the resistance of solids: the fluid which it sends them for nourishment must be proportioned to the marvelous fineness of the vessels. A blood such as ours would not circulate. The blood of the embryo at first is a whitish liquid; it turns yellow by degrees and finally becomes red. The impulse of the heart dilates the vessels more, and they admit larger particles, heterogeneous and colored.

The generative liquor is not, therefore, a simple stimulant: it is besides a nourishing fluid, appropriate to the extreme delicacy of the parts of the germ. It fulfilled already in the body of the fertilizing individual the functions of a nutritive fluid: it made the comb and spurs grow and gave strength to all parts. You recall the degeneracy of the capon, and how it differs from the cock. You might have many more proofs that the generating fluid is the first aliment of the germ.

Transported by the arteries to all the parts, it unites with them in a fixed manner, according to the proper nature of each. The chick is not slow to lose its form of tadpole. Wings, legs and feet proceed out of the long tail; everything comes out, fashions itself and arranges itself on a new model. The little animal, stretched out at first in an almost straight line, curves itself more and more. It invests itself more and more with muscles, tendons, bones and feathers, and in 18 or 20 days it is a perfect chick. B.

* From *Science*.

## THE DYNAMICS OF THE ATMOSPHERE.

Under this title a series of articles appeared in the *Meteorologische Zeitschrift* for May, August, and September, 1893, from the pen of Prof. M. Moller, of Brunswick, which treat of many of the important processes that are at work in our atmosphere. The following review is made by *Nature*.

The principal feature in these discussions is that the author treats the various phenomena as the result of complicated processes, and inquires into their character separately, prior to attempting to draw conclusions from them, so that some relations are presented in a new form.

With regard to the part which aqueous vapor plays in the atmosphere, it is usually stated that the heat set free in condensation during the formation of clouds greatly favors the origin of ascending air currents, but Moller takes another view of the matter. Two columns of air have usually been compared with each other, having at their base similar initial temperature, but in which the decrease of temperature with height proceeds in a different manner, as one column is supposed to contain dry air that is very cold at the upper end and the other moist air warmed by condensation. But the author considers that this difference of temperature does not actually occur in this manner, and that all theories based upon this assumption must lead to erroneous results. He states that as the air of the upper strata has risen up previously, it has consequently gone through the process of warming by condensation, so that the increase of heat caused by condensation cannot produce by itself a higher temperature in the ascending current than that possessed by the surrounding air; hence the cause of the upward impulse, which has been attributed to the aqueous vapor of the air, disappears. If it is wished to produce a circulation of the air in two vertical tubes in communication at both ends, the air in the bottom part of the one tube must be warmed, while that in the upper part of the other tube is cooled; but if the source of heat is applied at the top, a condition of stable equilibrium and rest takes place. In the same way the condensation of the aqueous vapor causes a warming of the upper strata of air, the effect of which is generally to produce a condition of stable equilibrium, contrary to the theory which assumes that the condensation of the vapor favors the ascending current, and consequently gives rise to depressions. The author attributes the chief cause of the origin of cyclones to horizontal differences of temperature in the earth's atmosphere, to the steep gradients of the upper strata caused by them, and the consequent strong movements of the air in those regions. He agrees in the main with the views of Ferrel, but attributes greater importance to the effect of friction against the rough surface of the earth. The air which rises at the equator, and moves in the upper regions toward the pole, takes, according to the law of the preservation of the moments of rotation, a west to east velocity, whose right-handed deflective force in the northern hemisphere is opposed to the poleward motive effect of the upper gradient.

According to Prof. Moller, this right-handed force over the dry zone, in the belts of high pressure, on both sides of the tropics, and in higher latitudes, becomes so great that a condition of equilibrium of the forces is produced in the direction of the meridians. Apart from local disturbances, the upper wind here follows the parallels of latitude, unless owing to friction, or the mixing of the upper and lower strata, a diminution of the upper current occurs, whereby the meridianal deflecting force of the upper gradients gains the mastery over the decreased right-handed deflective force arising from the centrifugal effect. Only then, and in proportion as this diminution of the upper current occurs, does the upper current follow the meridianal upper gradient. In this case a part of the energy gained in the upper currents of the atmosphere is transferred to the lower strata, so that there the velocities which are directed from west to east increase. The atmosphere, therefore, in the temperate and polar zones, is like a caloric machine, which first produces by meridianal gradients of temperature the upper gradients of pressure, and consequently an air current from west to east at a great height, whose transference to the lower strata of air depends upon opportunities of friction or mixture of masses of air. The meridianal advance of air in the upper air current is checked by the centrifugal force; for the advance to the pole increases the velocity of the west wind, and thus the centrifugal right-handed deflective force whose effect stops the meridianal advance of air to the pole. Moller states that this important relation of interchange was not clearly expressed in Ferrel's theory. He first assumes that a circulation between the hot and cold zones takes place unhindered, and, provided the circulation takes place, he makes the high velocities to exist in the upper current. Ferrel also computes the great forces which would be necessary in order to produce those high velocities, and he admits that these really do not exist. He speaks of this theory as only approximately correct, whereas the computed forces and great meridianal differences of pressure fail in nature, and the high westerly wind velocities, such as his theory requires, do not exist.

Prof. Moller concludes (1) that the regular and undisturbed circulation of the atmosphere between the hot and cold zones is not accomplished in the manner hitherto supposed, and as has been presumed in Ferrel's calculations, and states that if Ferrel's theory is to become of practical use, it will be necessary to study more exactly the relations between the friction of air on the surface of the earth, and especially the friction or the mixture of air between upper and lower strata. (2) If friction of air against the earth's surface is great, the velocity of the winds is less; but if friction, or mixture of air, between upper and lower strata is great, then the lower winds blow more violently. (3) In higher latitudes no storm can be caused by horizontal meridianal gradients of temperature without mixture or friction between the upper and lower strata.

## SUPPOSED EVIDENCES OF A POST-GLACIAL SUBMERGENCE IN EUROPE.*

By Prof. G. Frederic Wright, D.D.

The theory of an extensive post-glacial "submergence of Western Europe and of the Mediterranean coasts, at the close of the glacial or so-called post-glacial period and immediately preceding the neolithic or recent period," has recently received the high indorsement of Prof. Joseph Prestwich, lately retired from the chair of geology at Oxford, England. Prof. Prestwich's discussions of the subject have mainly appeared within the year past in two lengthy papers, prepared with his accustomed careful attention to all details. One paper with the above title is published in the "Philosophical Transactions of the Royal Society of London," Vol. 184 (1893), pp. 903–984. This deals with the evidence upon the Continent. The other paper appeared in the "Quarterly Journal of the Geological Society of London" for May, 1892, Vol. 48, pp. 262–343, and treats of the evidence in Southern England. The facts upon which Prof. Prestwich bases his inferences are those relating to the so-called "rubble drift," raised beaches and fissures filled with the bones of recent extinct animals. All these phenomena appear in Southern England, Northern France, and around the shores of the Mediterranean to Syria.

The rubble drift is something like the ordinary talus found at the foot of precipices and hills, only it is distributed further from the base than is possible if it were due to ordinary agencies. The material is local, is too angular to have been transported far, is all derived from the higher ground (though not necessarily from very high ground), is devoid of marine and fluviatile shells, but has occasional mammalian bones and land shells, and does not show regu-

* From the *Independent*.

lar stratification, and occurs outside of the range of glacial ice. In Prof. Prestwich's opinion the efforts to account for this singular and so widely scattered deposit by the wash of the surface debris over the edges of old cliffs, aided by excessive annual rainfall and by floating ice, are unsatisfactory; while the theory of deposit by waves of translation is proved inadequate by the unworn character of the material. The theory that the rubble drift was distributed by the sliding of miniature avalanches of snow and ice over the slopes is also quite improbable, since the slopes are often so slight. Mr. Prestwich, therefore, brings forward the novel theory that this distribution was produced by a series of short and sudden elevations of land which had been temporarily submerged at the close of the glacial period. This submergence he supposes to have extended to a depth of more than a thousand feet, and to have taken place gradually; but the re-emergence was more rapid and by sudden, short impulses, with unknown periods of rest between. Hopkins had shown that in such a depth of water a paroxysmal elevation of from 50 to 100 feet might produce a current of from 5 or 6 to 15 or 20 miles an hour.

"Movements of this character would, like Nasmyth's hammer, be capable at times, when the uplift was rapid, of exerting an enormous force, while at other times, when the uplift was slow, the action might be of the most gentle character."

It should be remarked, however, that Prof. Prestwich had overlooked Darwin's explanation of the phenomena as given in Geikie's "Prehistoric Europe," in which the genius of this great naturalist appears at good advantage. Darwin suggested:

"During the height of the glacial period great beds of frozen snow accumulated over Southern England, and during the summer gravel and stones were washed from the higher land over its surface. . . . Thus alternate layers of frozen snow and drift would ultimately have covered the country to a great thickness. . . . As the climate became warmer the lower beds of frozen snow would have melted with extreme slowness, and . . . the drift would have been deposited almost irrespective of the outline of the underlying land" (p. 141).

The evidence of organic remains found both in this rubble drift and in numerous rock fissures is supposed by Prof. Prestwich strongly to support his theory. The destruction of land animals is known to have been very extensive during that period, and their remains are clustered together as if they had been drowned while taking refuge on the higher lands, upon which the water was very slowly encroaching.

"The evidence of the organic remains is to the same effect, in that they are those of a *land fauna* alone, with an entire absence of marine and fluviatile remains. The bones found in the rubble drift are not only in the same unworn condition as the rock fragments, but they are *free from all marks of gnawing*. This is a proof that the animals had not, as in the caves, fallen a prey to carnivora, but must have met their death in a way which was unusual—such as from drowning; for had their bodies remained on a land surface after death, they would have been subject to being devoured by predaceous animals, or else the bones would have shown traces of weathering and wear. At the same time the *sharply* fractured state, and dispersion of the bones, show that they must have been subjected to considerable violence and displacement. These conditions, as well as the mode of distribution of the rubble from many independent centers, accord in all points with the results that would ensue from the submergence and re-elevation of a land surface from beneath deep waters after a temporary submergence."

It should be said, however, that the evidence of the raised beaches in post-glacial time is not very distinct anywhere in Europe, except on the coast of Norway, and that Sir Archibald Geikie, in the recent edition of his "Geology," and Alfred R. Wallace, in a late discussion of the subject in the *Fortnightly Review*, do not give their adhesion to the theory of an extensive subsidence, either post-glacial or inter-glacial, in Southern England. But the subject is, at the present time, exciting the liveliest interest among British geologists.

Oberlin, O.

## TOBACCO.*

By H. B. Cox.

### HISTORY.

IT has been said that the name tobacco was given to the plant by the Spaniards, because it was first observed by them at Tabasco or Tobaco, a province of Yucatan, in Mexico. Others derive the name from the "tabac," an instrument used by the natives of America in smoking this herb.

The use of tobacco for smoking and chewing purposes is supposed to have been commenced by the North American Indians at a very early period, so early, in fact, that nobody seems to have any idea as to when that period was. It is said that the Spaniards became acquainted with tobacco when they landed in Cuba in 1492, and on their return introduced it into Europe, strongly recommending it for its valuable medicinal properties, about which they probably knew nothing at all.

The custom of inhaling the smoke was learned from the Indians, and by the end of the sixteenth century had become generally known throughout Spain and Portugal, whence it passed into the rest of Europe, and into Turkey, Egypt, and India, although severely opposed and forbidden both by the Christian and Mohammedan governments. Tobacco was introduced into China during the sixteenth century, although its use was strongly prohibited.

It was not till the middle of the sixteenth century that tobacco was seen growing in Europe, first at Lisbon, when the French ambassador, Jean Nicot (hence the name Nicotiana), sent seeds to France in 1560, as those of a valuable medicinal plant, which was, even then, diffused throughout Portugal.

When America was first discovered, and afterward when fresh tracts of the country were explored, the practice of smoking tobacco was found to be prevalent among all the tribes. Tobacco was introduced into Italy in 1560, this being about the same time as its introduction into France. Tobacco was probably first brought into this country in 1565 by Sir John Hawkins, or, at any rate, it seems unlikely that Sir Francis Drake, who is believed to have brought tobacco from Virginia in 1586, was the first to bring it into England.

Perhaps it is safe to assume that Sir Walter Raleigh and his companions were the first in this country to use the herb for smoking purposes; this was in 1584.

One thing, however, is very certain, and that is that the custom of smoking tobacco very quickly succeeded its introduction, and the growth of this habit, in spite ot the most strenuous opposition, cannot fail to strike us as remarkable.

### SOURCE.

Tobacco is the leaf of *Nicotianum Tabacum* and allied species. The genus *Nicotiana* contains about seventy-three species. Of the various species, *N. Tabacum* is by far the most extensively cultivated. It is a fine plant, growing to a height of six or seven feet. The leaves are sometimes two feet in length, and average about eighteen or twenty inches; they are very shortly stalked, and the base is more or less amplexical; the flower is pink, or pale red. It constitutes a very large proportion of commercial tobacco, being known and cultivated nearly all over the world.

American tobacco is almost exclusively of this species, although many varieties of it are now recognized, such as Kentucky, Big Frederic, Virginia, etc. The same plant furnishes the tobacco of Havana, France, Holland, Belgium, and others. The next important species is *N. Rustica*, or Syrian tobacco. This is a much smaller plant, averaging three and a half feet in height; it has a greenish flower; it furnishes the Turkish, Syrian, and perhaps the Latakia tobaccos. It is a native of America, but is now cultivated chiefly in Asia, Africa, and Europe. It is a hardier plant than *N. Tabacum*.

The third important tobacco is *N. Persica*, which has a white flower. These three species probably constitute the whole of the tobaccos grown, although each has many varieties, especially the first, *N. Tabacum*, which almost invariably forms a fresh variety when it is transplanted.

Until quite recently, "Tumbeki," the Persian tobacco of Eastern commerce, was thought to be the produce of *N. Persica*, some few experts holding the opinion that it was obtained from *N. Rustica*.

This led to much discussion, followed by much conflicting literature, so that seeds of the plant which yielded the tobacco in question were obtained from various reliable people in Persia, and sown at Kew. Meanwhile entire plants were also examined and resembled neither *N. Rustica* nor *N. Persica*, and when the plants grown from the seeds received from Persia were examined they turned out to be those of *N. Tabacum*. This was published in the *Kew Bulletin* for 1891, p. 84.

Not feeling quite convinced on the subject, on account of the various opinions obtained from different sources, I wrote to Kew recently, and a few days ago received the following reply from the director, Mr. W. T. Thiselton Dyer, F.R.S., etc.:

"DEAR SIR: As to Shiraz tobacco, there is no ambiguity as to the conclusion arrived at in the *Kew Bulletin* for 1891, p. 84. What is ordinarily called Turkish tobacco, and as far as I know only used for cigarettes, is the produce of *Nicotiana Rustica*."

This note on the source of Turkish tobacco is in harmony with the statement previously made by me, which I wrote some time ago.

### CONSTITUENTS.

The characteristic organic constituent of the tobacco plant is the alkaloid nicotine, with which is generally associated the essential oil or "tobacco camphor," viz., nicotianin. The proportions which all the organic substances in the plant bear to one another greatly affect the aroma and taste of the tobacco. The burning is somewhat influenced by them, but far more by the mineral or inorganic constituents present.

The freshly cut leaves contain over 80 per cent. of water, and the proportion of nicotine varies from 1 to about 10 per cent.

Syrian is one of the lowest; that is, as regards the percentage of nicotine it contains. Two distinct samples that I examined, although widely differing from each other, gave an average of only 0·852 per cent., the actual figures being 1·093 and 0·612

The process of determination was as follows:

Twenty-five grammes (or more or less, according to the amount of the sample at my disposal) of the dried and powdered tobacco was intimately mixed with slaked lime and distilled in a current of steam until the condensed steam was no longer alkaline; the distillate was slightly acidulated with dilute $H_2SO_4$, and evaporated to a conveniently small bulk. This was made alkaline with soda, and agitated repeatedly with successive portions of ether. The separated batches of ethereal solution of nicotine were then mixed and exposed to the air in a cool place. This exposure to the air carries away ammonia, if any be present, as well as ether.

Water was added to the ethereal residue, and the amount of nicotine present determined by decinormal $H_2SO_4$, using methyl-orange as an indicator. One c. c. of decinormal $H_2SO_4$ represents 0·0162 gramme of nicotine ($C_{10}H_{14}N_2$).

It is important that the nicotine should not be left about longer than is absolutely necessary, since it is appreciably volatile at the ordinary temperature.

Sometimes the unconcentrated ethereal solution is titrated, but in such cases ammonia, if present, would make the results high. The neutralized solution is therefore separated from the ether and evaporated to dryness over a water bath and weighed. Some prefer to add a few cubic centimeters of decinormal acid before evaporating, and these would, of course, have to be taken into account.

The residue is treated with absolute alcohol, which dissolves the sulphate of nicotine, but not the ammonium sulphate; the latter must be dried, that is, freed from alcohol and weighed, and this weight, deducted from the weight previously obtained of nicotine sulphate, will leave the absolute weight of nicotine sulphate $(C_{10}H_{14}N_2)_2H_2SO_4$.

*Table of Results, Arranged According to Per Cent. of Nicotine.*

| Variety examined. | Amount of moisture present in sample, per cent. | Total ash, per cent. | "Alkaline salts," *i. e.*, ash sol. in HCl, per cent. of 100 pts. ash. | Nicotine, per cent. |
|---|---|---|---|---|
| 1. Syrian leaves (*a*) | 8·70 | .... | .... | 0·612 |
| 2. American chewing | .... | 20·6 | 58·25 | 0·935 |
| 3. Syrian leaves (*b*) | 8·00 | .... | .... | 1·093 |
| 4. Chinese leaves | 6·12 | .... | .... | 1·902 |
| 5. Turkish (coarse cut) | .... | .... | .... | 2·500 |
| 6. Golden Virginia (whole strips) | 14·00 | 17·82 | 70·70 | 2·501 |
| 7. Gold Flake (Virginia) | .... | 18·10 | 71·60 | 2·501 |
| 8. "Navy cut" (light colored) | .... | 18·6 | .... | 2·530 |
| 9. Light returns (Kentucky) | .... | 16·1 | 61·11 | 2·733 |
| 10. "Navy cut" (dark "all tobacco") | .... | 16·6 | .... | 3·640 |
| 11. Best "Bird's-eye" | .... | 16·0 | 54·33 | 3·931 |
| 12. Cut Cavendish (*a*) | .... | 18·62 | 70·90 | 4·212 |
| 13. "Best Shag" (*a*) | .... | 15·46 | 80·25 | 4·907 |
| 14. "Cut Cavendish" (*b*) | .... | .... | .... | 4·970 |
| 15. "Best Shag" (*b*) | .... | .... | .... | 5·000 |
| 16. French tobacco | .... | 17.29 | ... | 8·711 |
| 17. Algerian " (*a*) | .... | 17·29 | .... | 8·813 |
| 18. Algerian " (*b*) | .... | 17·40 | .... | 8·900 |

The above list includes no proprietary tobaccos, and it must not be inferred that the samples examined were standard samples. They were obtained from very different sources, no two samples of one kind being obtained from the same source. The ash was not determined in Nos. 1, 3, 4 and 5 for want of material, while the examination of Nos. 15, 16, 17, 18 was incomplete for lack of time.

The average percentage of nicotine in Syrian tobacco is from 1 to 2; in Manila and Havana 1 to 3; Virginian and Kentucky up to 7; French up to 9. The French and Algerian samples which I examined resembled each other very closely in every way, which may probably be explained by the fact that much of the Algerian tobacco is imported into France and manufactured at the government factories.

It is supposed that the aroma given off during the smoking of tobacco is due rather to the nicotianin or tobacco camphor than to the nicotine, although the former is present only to a very small amount. The odor given off from an aqueous solution of nicotine, however, was variously described to me as like that of senna tea or a saucepan that cabbage has been boiled in.

The conditions of soil and climate which favor the production of nicotine retard that of nicotianin and *vice versa*. The quantity of nicotine present is no criterion of the quality of the tobacco, inasmuch as many of the most delicately flavored and choice tobaccos contain little of it. The cellulose, gum, etc., in the leaf give off objectionable odors in burning, and fermentation gets rid of or modifies these when present in considerable quantity. The fermentation must not, however, be excessive, or objectionable and injurious ammoniacal salts would be formed. Many tropically grown varieties contain little of these unpleasant constituents, so that in some cases fermentation is dispensed with, and in many others is greatly lessened, sun drying alone often proving sufficient for the preparation of the leaves. The chief organic acids in tobacco are malic, citric, and oxalic, while acetic acid has been found in fermented tobaccos.

The ash of tobacco varies greatly in composition and quality, although the percentage is from 12 to 20; it invariably contains potassium, sodium, calcium, magnesium, aluminum, usually a trace of iron oxide, and carbonic, phosphoric, silicic, and sulphuric acids, and chlorine.

Potash is sometimes present to the extent of 30 per cent. of the total ash, and should be mainly combined with the organic acids. The ready decomposition of the organic potassium salts by heat constitutes a good burning tobacco. The potassium salts are converted into carbonate in burning, and consequently the combined presence of potassium and carbonic anhydride in the ash may be taken as a good indication. From the excess of these two, of course, it follows that the other constituents must be present in smaller proportions, the lime generally lower than the potash, with smaller quantities of magnesia, soda, and alumina. Iron is objectionable, giving a red ash. Lithium is present in the ash of most tobaccos. Silicic and phosphoric acids, even in considerable quantity, do not seem to affect the combustion to any great extent, but chlorine, except in very minute quantity, retards it.

The leaves contain more calcium, magnesium, and silicic acid, and less alkali, phosphoric acid, and chlorine than the stalks. The stalks contain much potassium nitrate, and their presence in "bird's-eye" tobacco renders this tobacco very readily combustible without any addition.

According to Nessler, tobacco burns best when it contains a large proportion of potassium malate, but the effect may be imitated by the addition of acetate or other organic potassium salt. The combustibility may be diminished by the addition of magnesium or calcium sulphate. Sulphates seem to favor proper combination. Mayer observes that tobacco which burns badly can be made to burn well by steeping it for twenty-four hours in a 0·5 per cent. solution of potassium acetate or nitrate. A solution of calcium acetate of the same strength gives excellent results, as I have proved.

Tobacco seeds yield by pressure 30 per cent. of a greenish-yellow, mild, odorless oil, having a sp. gr. of 0·923 at 15° C. This oil quickly dries by exposure to the air.

### IMPORTATION.

The forms in which tobacco is imported into this country are many, each variety being purchased according to its suitability for the preparation of some fancy tobacco, and although commercial tobacco is

* Read at a meeting of the School of Pharmacy Students' Association, January 11, 1894.—*Amer. Druggist.*

divided into five classes, every manufacturer has his own method of selection.

The chief imported varieties are Virginian, Kentucky, Maryland, Indiana, Java, China, Japan, Ceylon, Turkish and German. The largest quantities come (1) from the United States of America; (2) Germany; and much less from Japan, India, China, and Eastern countries.

Imported tobaccos generally contain about 14 per cent. of water, although apparently dry and brittle.

### MANUFACTURE.

The bulk of imported leaves are used for the manufacture of the fancy tobaccos, the material being chosen according to the variety of salable tobacco required.

Shag is usually made from the darker and stronger varieties.

In "bird's-eye" the prepared leaves are placed in such a manner upon one another that they will be cut right across the mid-rib.

For "twist" or "cake" tobacco the leaves are stripped, moistened, and placed end to end, and then spun into a rope round a reel, or wound into a ball, either by hand, or by a spinning wheel. The whole is then steeped in liquor, and finally oiled with sweet oil. The oiling process greatly affects the ready burning of this tobacco.

In America it is usual to saturate the leaves and stalks previous to pressing into cakes with molasses, or a mixture of this substance and licorice. I have extracted a considerable quantity of glycyrrhizin from this cake tobacco, and have also found ligulate florets in it.

Leaves which are to be made into cigars must possess the following qualities: They must he of good color, possess a fair amount of body, and an agreeable odor, and must give off an agreeable aroma when burning, and last, but by no means least, they must burn well. It should also be mentioned here that a fine texture and small veins are favorable characteristics. A machine is now in use by which mid-ribs and stalks are flattened by pressure, so that they may appear like parts of the lamina.

The "burning test" is to ascertain whether the leaves will continue to burn after being once lighted, although this can be no guide as to the quality of the cigar. Sometimes cigars are made of tobacco which will only burn very slowly and difficultly, in which case it is the rule to mix "fiery" tobacco with them, but this method produces only inferior cigars, and unless they are made with extreme care they do not hurn evenly.

The best cigars are made of one kind of leaf only, but in common kinds the interior is a mixture, made up of stalks, etc., concealed in an attractive wrapper. In many foreign cigars the wrapper has been found to contain much potassium nitrate. while the interior, consisting of the same kind of tobacco, contains none. This is added so as to make the wrapper burn down evenly with the interior. Glycerin is said to he sometimes added to keep the cigars from becoming too dry.

Cigars are rarely adulterated, and though not always what their outside would represent them to be, they contain nothing but tobacco. Cases have been reported of cigars containing hay, cabbage, and brown paper, but such cases are extreuely rare.

The chief imposition seems to be the practice of placing home-made cigars in imitation foreign boxes. Another custom is to send German and other Continental tobaccos to the West Indies, whence they return as a special hrand of West Indian cigars.

Cigars chiefly come from the West Indies (and these, of course, include the German ones), the Philippine Islands, and, recently, from Mexico and Jamaica.

Cigarettes are usually made of light tobacco, such as Turkish, Salonica, etc., which has but little odor, and this a pleasant one. American tobacco is largely used for this purpose.

Snuff is made from finely powdered tobacco stalks. The moisture should not exceed 25 per cent., hut is sometimes present to the extent of 50 per cent. It is variously scented. In the United Kingdom nothing is allowed to be added to snuff except the carbonates, chlorides, and sulphates of potassium and sodium, and the carbonate of ammonium.

### ENGLISH-GROWN TOBACCO.

From the very first the cultivation of tobacco in England was a success, hut this was prohibited hy James I. and Charles I., though with little effect. The home grown tobacco was heavily taxed, and it was expected that this would cause the cultivation to be dropped for want of profit. This heavy taxing was due in a great measure to the difficulty experienced in collecting the duty, which was extensively evaded. In 1652 the cultivation in England was prohibited, and shortly afterward an order was issued to destroy the plantations. The illegal growth, however, continued, and the cultivation was not finally stopped until the reign of George III., when, in 1782, an act to this effect was passed, and the tobacco trade was forced out of the country.

Extensive plantations in Yorkshire were by this act destroyed, and the planters heavily fined and imprisoned.

The growth of tohacco in Ireland was not so hampered by opposition, and so it managed to struggle on till 1831, when it was suddenly suppressed.

In 1886, owing to the agricultural depression in this country, the question of cultivating tobacco in England was once more raised. Permission was sought and obtained, with severe restrictions, to make experiments on the subject.

The results were, to say the least of it, promising, although nobody expected we should be ahle to grow Havana cigars in Kent, even though they do make them in Germany.

In 1887 permission was again ohtained, but as soon as the new industry sprang up in this country it encountered tremendous opposition and was finally stopped.

Some samples of English-grown tobacco were analyzed and found to contain, on the average, light leaves 3·6 per cent. and the dark leaves 2·4 per cent. of nicotine. It will be noticed that the proportion of alkaloid in the light leaves was higher than in the dark, the reverse of what is usually the case.

## RICE MEAL OR BRAN.

This is a material which agriculturists have during recent years been using increasingly and with ample justification, for even now it deserves to be more generally appreciated. Bearing in mind the extremely starchy character of the grain furnishing it, for as it is taken in this country rice is certainly one of the most farinaceous foods, some little surprise may be experienced that a material of the description this proves to be is yielded as a by-product of its preparation for the market, the meal consisting of the removed outer coatings of the seeds, although in many respects wheat bran is similar, and is also, as we know, valuable to the farmer.

It is, however, highly important to procure genuine rice meal when purchasing, as many channels are open for the substitution of an inferior article; thus a material known as rice husks is occasionally met with, which is altogether different in character and feeding value; consequently any one huying a supply consisting partly or entirely of this would suffer to a corresponding extent. Again, there is some considerahle risk that sweepings and other warehouse refuse would find an entrance; indeed, from time to time samples are received which, owing to this cause, are totally unfit for use as food; further, there can be no doubt that this material sometimes suffers from admixture with the products of other grain, its physical character rendering it especially adapted to undergo such treatment, thereby affording an admirable and convenient vehicle for the disposal of damaged wheaten flour, etc.

Some of the extraneous matters that might be introduced would exert a positively injurious influence, while others, not in themselves objectionahle, must materially diminish the value of the meal by lowering the percentage of oil, and any description of intentional admixture, if the product he sold as genuine, is necessarily fraudulent; clearly, therefore, buyers and *bona fide* sellers need to be on their guard, the one to protect his pocket and the other to prevent his goods falling into disrepute through the action of unscrupulous or careless dealers. Certain varieties of the meal are red and dark in color, and do not meet with a favorable reception; the hest qualities have a light shade, being not much browner than oatmeal.

The advantages of rice meal are its high percentage of oil, which averages ahout 12 per cent., some samples containing as much as 15 per cent. The oil is one that hecomes solid at ordinary temperatures, possesses a sweet odor and agreeable taste, and is in every way a satisfactory food constituent; consequently, at ahout its usual price, £4 per ton, this material provides a cheap source of that principle whose value in feeding stuffs we recently commented upon.

The mild and pleasant flavor of the meal is also an important factor, for obviously it is thus rendered free from any objection as heing likely to impart undesirable properties in this respect to dairy produce, while the richness of the ash in phosphoric acid assists in making it well adapted to the preparation of young animals' natural food; therefore numerous and manifest reasons for adopting it as part of the rations of milk cows are apparent, and for this purpose a considerahle demand exists, and the proportion of oil being advantageous in the production of cream, while its nature and quality necessarily promote the yield of a well flavored butter.

The chief drawback when using rice meal is the comparatively low percentage of nitrogen it contains, which is equal to about 12 per cent. of albuminous suhstances; nevertheless, with the exception of only a small proportion, these consist of albuminoids, and they, as nutrients, are hy far the most valuable constituents containing this element. However, an increase in the quantity present may be made with advantage, and as the percentage of oil is so considerahle, it is possible to mix with materials poor in that ingredient and yet ohtain a food supplying a satisfactory amount. For example, hy adding beans and peas to rice meal in the proportion of two-thirds of the latter to one-third of the former, a valuable and digestible feeding stuff may be prepared, for these leguminous seeds, although poor in oil, are very rich in nitrogen. Assuming heans to be employed for the purpose, a mixture of the kind would have a composition corresponding approximately with the analysis given below, which at once reveals its value to the farmer. With the ohject of facilitating comparison, we also give the results ohtained from a good sample of rice meal alone:

| | Mixture. | Rice Meal. |
|---|---|---|
| Moisture | 11·68 | 10·42 |
| Oil | 8·82 | 12·36 |
| Albuminous compounds* | 16·31 | 11·94 |
| Carbonaceous principles | 46 79 | 46·55 |
| Phosphates, etc | 5·83 | 7·45 |
| Fiber | 9·21 | 9·25 |
| Insoluble matter | 1·36 | 2·05 |
| | 100 00 | 100·00 |
| * Containing nitrogen | 2·61 | 1·91 |

By exercising reasonable precautions when purchasing, it is evident that in this material agriculturists possess a food which may be made exceedingly useful. —*Bell's Messenger, London, January* 29.

## PROFITABLE RICE CULTURE.

Within a few years it has been found practicable to raise rice on the dry lands of Southwestern Louisiana to greater advantage than in the swamps of the Atlantic coast. Of course artificial irrigation is essential, but rice culture in the swamps of the Carolinas is decaying, while in Southwestern Louisiana it is growing rapidly and yielding ample returns. A couple of years ago the crop was excessive, but the last crop is well sold up, and there is little douht that the consumption of rice will vastly increase in this country. Scientifically and practically it is one of the hest foods, and the taste for it is growing. Portions of this section of Louisiana are sufficiently watered by natural overflow, but a good deal of it is scientifically irrigated. Some of the farmers say it is a little more work to cultivate rice than wheat and corn, but most of them think it is less; there is no great difference in the cost. The general testimony is that it costs $5 or $6 an acre to cultivate it, exclusive of irrigation, which, as already said, is not always necessary. A dollar for seed, $2 for cultivation and $2 for harvesting is the estimate of many farmers, though a few put the cost $1 or $2 more and some go as high as $10 or $12. Ten barrels in the rough is regarded by many cultivators as a fair average crop, hut yields of twelve and fifteen barrels are common. The farmers generally get from $2 to $3 a harrel and sometimes a little more. A rice cultivator at Lake Arthur, Louisiana, writes: "I can say honestly and positively that a man can make a hig fortune in four or five years raising rice. . . . I know a number of farmers that have for the past three years averaged fifteen barrels per acre, and their net average price per barrel for the three years was $2.85." These figures give gross receipts of $42.75 per acre.—*N. Y. Jour. of Com.*

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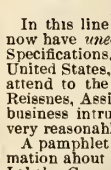

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## THE EMPEROR WILLIAM AND HIS FAMILY.

FRIEDRICH WILHELM, or William II., as he is usually called, the present Emperor of Germany and King of Prussia, is the eldest son of the late Emperor Friedrich III. and Victoria, Princess Royal of England, daughter of Queen Victoria and Prince Albert. The Emperor William was born January 27, 1859, and was educated at the Gymnasium of Cassel, submitting to the ordinary discipline of that excellent educational institution. In 1877 he was sent to the University of Bonn, which is situated on the Rhine, near Cologne. On his twenty second birthday (1881) he married the Princess Augusta Victoria of Schleswig-Holstein-Augustenburg, a niece of Prince Christian. William II. is the third emperor of the present German empire, which was founded April 16, 1871. His grandfather, William I., died March 9, 1888. Friedrich reigned but little more than three months, dying June 15, 1888. William II. then succeeded to the throne.

The emperor has great power—the right and duty

THE EMPEROR WILLIAM AND HIS FAMILY.

of representing the empire for all purposes of international law devolving upon him. The emperor also declares war and peace, and is the commander-in-chief of the army and navy in time of war, and also, with trifling exceptions, in time of peace. His edicts are made in the name of the empire, and must be signed by the chancellor.

The principal events which have occurred in Germany since the present emperor succeeded have been, first, the rise of the anti-semitic movements, which resulted in the exposure of stupendous frauds; second, the system of uniform time, which was adopted March 31, 1893; thenceforth the mid-European time—that of the 15th degree of longitude east of Greenwich, obtains all over the country; the army bill; and lastly, his trouble with Bismarck and his reconciliation to the "Iron Chancellor," which is still fresh in the memory of all. The emperor is very fond of traveling, and considerable time each year has been spent in paying visits, catching whales, etc. In 1890 his imperial majesty paid a state visit to Heligoland; in 1891 to Amsterdam, and later in the year, accompanied by the empress, he visited England, where he was fêted and presented with the freedom of the City of London.

In April, 1893, the emperor attended the silver wedding of the King and Queen of Italy, and took this opportunity of visiting Pope Leo XIII. In July of the same year he won the Queen's Cup in the races at Cowes. The total income of the emperor is about 15,719,000 marks, or $3,752,000.

The emperor has seven children. The eldest, the Crown Prince of Germany and Prussa, is Prince Friedrich-Wilhelm-Victor-August-Ernst, born May 6, 1882. The second child is Prince Wilhelm-Eitel-Friedrich-Christian-Karl, born July 7, 1883. The third is Prince Adalbert-Ferdinand-Berenger-Victor, born July 14, 1884. Prince August-Wilhelm-Heinrich-Victor was born January 29, 1887. The fifth child, Prince Oscar-Karl-Gustav-Adolf, was born July 27, 1888. The sixth child is Prince Joachim-Francois-Humbert. He was born December 17, 1890. The youngest is a girl, Princess Victoria-Louise-Adelaide-Mathilde-Charlotte. She was born September 13, 1892. The emperor has one brother and four sisters. For our illustration we are indebted to *Illustrirte Zeitung*.

## CEMENT TESTING.

By Spencer B. Newberry.

The manufacture of hydraulic cement is an operation requiring the greatest care and skill. The selection, preparation and mixing of the raw materials, the burning of the charge, and the sorting and grinding of the product, must all be carefully controlled, or serious defects in the finished cement will result. The faults shown by bad cements are, moreover, generally not trifling ones, nor immediately evident, but often consist of hidden and dormant evils, which may cause the failure and destruction of important pieces of engineering work after the lapse of months or years. It is evident, therefore, that simple and rapid methods of detecting these hidden faults, and of determining the comparative values of different samples of cement, are absolutely indispensable to all engaged in the many kinds of constructive work in which cement is used.

The chief uses of hydraulic cement are in making concrete foundations, mortar for brick and stone, sidewalks and flooring, cistern, reservoir and aqueduct linings, and in a variety of lesser applications, such as sewer pipes, tiles, and architectural ornaments. These uses require various qualities, among which the most important are probably the following:

Setting and hardening properties.
Strength under tension and compression.
Permanence in water and in air.

These are the qualities for which cements are usually tested, and may be simply and quickly determined. Other necessary qualities, such as resistance to wear, resistance to frost, impermeability to water, and adhesion to brick or stone, may generally be assumed to be present in satisfactory degree in cements which stand the usual tests, and depend to a great extent on the manner in which the cements—even those of best quality—are used.

The testing of cements, especially for tensile strength, is a delicate operation, and requires care and practice. The proportion of water used, thoroughness of mixing, temperature of the testing room, and manner of filling the moulds, must all be carefully noted and made uniform, or the results will show nothing but confusion. For this reason certain definite requirements and instructions for testing have been adopted as a standard in different countries. In the United States, the requirements of the New York Department of Docks and the Engineer Department of the District of Columbia are official statements of the qualities which good cements should show, but give little information as to methods of testing. The report of the Special Committee of the American Society of Civil Engineers (June, 1885) contains many valuable suggestions in regard to the manner in which the tests should be made. In Germany, the requirements of the Prussian Minister of Public Works are the recognized standard, and contain full and definite specifications as to methods of testing. The same is true of the official French requirements, which are those of the *Services Maritimes des Ponts et Chaussées*. It is remarkable that in England, the birthplace of the Portland cement industry, no agreement in regard to requirements or methods of testing has ever been reached.

It is the purpose of this paper to give a brief synopsis of these various requirements, together with a few notes taken from the author's own experience, in the hope that the matter thus presented may prove a convenience to American engineers. In stating the standard requirements of the United States, Germany and France, only a brief abstract is given, and all details which seem to the author to be unimportant are omitted. References are given, however, to the full text of the published specifications.

### REQUIREMENTS OF THE NEW YORK DEPARTMENT OF DOCKS, 1891.

*Time of Setting* to be determined by a wire $\frac{1}{24}$ inch in diameter, loaded to weigh one pound. Quick setting cement must set within one-half hour; slow setting cement must not set within one-half hour.

*Fineness* must be such that at least 90 per cent. shall pass a sieve of 50 meshes to the inch.

*Tensile Strength.*—Neat cement, 7 days (one day in air and six in water), at least 300 lb. Cement with two parts sand, 7 days, at least 125 lb.

*Constancy of Volume.*—A pat of the cement, on glass, placed in water when set, must show no cracks or distortions. A similar pat, when set, is exposed to steam at about 200° for 3 hours, then placed in boiling water for 24 to 48 hours, and must still adhere to the glass and show no cracks or distortions.

### SPECIFICATIONS OF THE ENGINEER DEPARTMENT, DISTRICT OF COLUMBIA.

*Natural Cement.*

*Fineness.*—Not less than 92 per cent. to pass a 50 mesh sieve, and not less than 80 per cent. to pass a 100 mesh sieve.

*Time of Setting.*—Initial set in not less than 10 nor more than 45 minutes.

*Tensile Strength.*—1 day (in air until set, rest of day in water), neat, 50 lb.; 7 days (1 day in air, 6 days in water), neat, 100 lb.; with two parts sand, 50 lb.; 28 days, neat, 150 lb.; with two parts sand, 100 lb.

*Portland Cement.*

*Fineness.*—Not less than 95 per cent. to pass a 50 mesh sieve, and not less than 85 per cent. to pass a 100 mesh sieve.

*Time of Setting.*—Initial set in not less than one hour.

*Tensile Strength.*—1 day, neat, 125 lb.; 7 days, neat, 400 lb.; with three parts sand, 100 lb.; 28 days, neat, 500 lb.; with three parts sand, 150 lb.

*Constancy of Volume.*—Portland cement shall not contain more than 3 per cent. of free lime, and shall withstand without cracking a temperature of 212 F. after immersion in water for 24 hours.

### RECOMMENDATIONS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The society appointed a committee to devise a uniform system for testing hydraulic cement. The report of this committee, presented at the annual meeting, January 21, 1885, is published in the Proceedings of the Society, June, 1885, and reprinted in full in the Scientific American Supplement, January 30, 1886. This report is generally regarded as the chief standard of reference among American engineers. The recommendations given are, however, chiefly general in character, and allow a good deal of latitude in methods of testing. The following are some of the most important recommendations contained in the report.

*Fineness.*—Cement of the better grades is now usually ground so fine that only from five to ten per cent. is rejected by a sieve of 2,500 meshes per square inch (50 mesh). The finer the cement, if otherwise good, the larger dose of sand it will take, and the greater its value.

*Checking or Cracking.*—Make two cakes of cement, two to three inches in diameter, ½ inch thick, mixed with water to the consistency of stiff plastic mortar. Note the time required to set hard enough to stand the wire test recommended by Gen. Gillmore, $\frac{1}{12}$ inch diameter loaded with ¼ lb., and $\frac{1}{24}$ inch diameter loaded with one lb. One of these cakes, when hard enough, is placed in water and examined from day to day to see if it becomes contorted or cracked. The remaining cake should be kept in air and its color observed.

*Tensile Strength.*—Cements are to be tested neat, natural cement also with one part sand; Portland cement with three parts sand. The amount of water required is approximately as follows: neat natural cement, 30 per cent.; neat Portland cement, 25 per cent. cement with one part sand, 15 per cent. of total weight; with three parts sand, 12 per cent. The mixing must be rapid and thorough; the mortar, which should be stiff and plastic, should be firmly pressed into the moulds with the trowel, without ramming, and struck off level.

The temperature of the briquettes and of the testing room should be constant between 60° and 70° F.

The sand recommended is the *crushed quartz* used in the manufacture of sand paper, of such fineness as to pass a 20 mesh sieve and be caught on one of 30 meshes.

The report includes drawings of the standard form of briquette recommended for adoption, which is now universally used in this country. Diagrams of moulds and clips and descriptions of the same are also given. A table of the average results of tests of natural and Portland cements, neat and with sand, is included. The figures for Portland cement are, however, greatly below those ordinarily given by the best grades at present on the market, and indicate that great improvement in the quality of cement has taken place during the past nine years.

### GERMANY—REQUIREMENTS OF THE PRUSSIAN MINISTER OF PUBLIC WORKS.*

*Time of Setting.*—Slow setting cements are those which set in not less than two hours. The time of setting is tested by making a pat of the cement, about one-half inch thick, with thin edges, on a plate of glass. The amount of water used should be such as to require several taps of the plate on the slab to cause the cement to spread to the edges; usually 27 to 30 per cent. water will give this result. The temperature of the room and of the water used should be from 15° to 18° C. (59° to 65° F.) The cement is considered to be set when it resists a light pressure of the finger nail.

Exact determinations are made by means of a normal needle of 1 square millimeter section ( = $\frac{1}{25}$ inch diameter) weighing 300 grammes (10½ ounces). A metal ring 4 centimeters (1⅝ inches) high and 8 centimeters (3 ⅛ inches) inside diameter is placed on glass and filled with cement paste of the above consistency. The time at which the needle ceases to pass entirely through the cement is called the *initial set*. The time which has passed when the needle ceases to make a noticeable impression represents the *time of setting*.

Portland cement becomes slower setting by long storage, and if kept dry gains in strength. Specifications requiring fresh cememt are therefore erroneous, and should be abandoned.

*Constancy of Volume.*—Portland cement must show no increase of volume in setting and hardening. This is to be determined by means of a pat of cement on glass as described for the determination of time of setting. Such a pat is kept for 24 hours in a closed box or under a damp cloth, then laid in water. After long periods it must show no radial cracks at the edges nor changes of form. The appearance of radial cracks or curving of the pat is proof of expansion of the cement. These generally appear, if at all, during the first three days; observation for 28 days is in all cases sufficient.

*Fineness of Grinding.*—Not more than 10 per cent. should remain on a sieve of 900 meshes per square centimeter (76 meshes to the linear inch) in which the diameter of the wire is one-half the width of the mesh.

*Strength under Tension and Compression.*—This is to be determined by tests of a mixture of cement and sand. Tests of neat cement are also recommended. Portland cement, with three parts sand, by weight, must show after 28 days (one day in moist air and 27 days in water) a tensile strength of at least 16 kilogrammes per square centimeter (227 lb. per square inch), and a compression strength of 160 kg. per sq. cm. (2,270 lb. per square inch). Washed quartz sand, which passes a sieve of 20 meshes to the linear inch, and is retained by one of 30 meshes, is to be used. This is to be compared as to results with the German normal sand (from Freienwalde on the Oder) furnished by the Royal testing station at Charlottenburg.

Briquettes are to be made as follows: For five briquettes weigh out 250 g. (9 oz.) cement and 750 g. (27 oz.) sand. Mix dry, add 100 c. c. water (3½ oz. by weight = 10 per cent.) and work strongly five minutes. The mixture is pressed into the moulds so as to fill them above the top, and pounded for at least one minute each with an iron spatula, at first gently from the sides, then more strongly, until the mass becomes elastic and water appears on the surface. The spatula should be 14 inches long, the blade 1½ by 2 inches, and should weigh about 250 g. (9 oz.) Briquettes are to be kept in a zinc-lined box for 24 hours, then placed in water

Briquettes may also be made by means of Dr. Bolme's hammer apparatus. One hundred and fifty blows on each briquette are automatically given, the hammer weighing 2 kilogrammes.

Test pieces for compression are to be of cubical form. 50 square centimeters (7¾ square inches) on a side. These are to be made of a mixture of cement with 3 parts sand, with 10 per cent. water. The moulds are to be filled by means of the hammer apparatus.

All tests are to be made immediately on taking the test pieces from the water. In tests of tensile strength the weight should be applied at the rate of 100 grammes (3½ oz.) per second.* The average of ten tests shall be taken as the correct tensile strength.

### FRANCE—REQUIREMENTS OF THE SERVICES MARITIMES DES PONTS ET CHAUSSEES †

*Density.*—A liter measure is loosely filled with cement, previously screened through a sieve of 180 meshes to the linear inch and weighed. (This test is used for comparison of different lots of the same cement, the weight of 1 liter of which must exceed a certain figure determined for the cement in question. No general requirement as to density is made.)

*Chemical Composition.*—Cement containing more than 1 per cent. of sulphuric anhydride (= 1·7 per cent. sulphate of lime) is rejected, while that containing more than 4 per cent. of oxide of iron is declared suspicious. Cement containing less than 44 parts of silica plus alumina to 100 of lime is also considered suspicious.

*Time of Setting.*—Room and water used are to be at temperature of 15° to 18° C (59° to 65° F.) The cement and water to be mixed 5 minutes with a trowel of stated dimensions; proportion of water to be such that a small quantity of the mixture will fall from the trowel without leaving any adhering portions, and if dropped on the slab from a height of about 20 inches will retain its form and show no cracks. The test for time of setting is made by filling a metal ring as described in the German requirements. The needle employed has a square section of 1 millimeter ($\frac{1}{25}$ inch), and carries a weight of 300 grammes. Cement which begins to set in less than 30 minutes or sets completely in less than 3 hours is refused.

*Constancy of Volume.*—Pats on glass are immersed in *sea water*, kept at temperature of 59° to 65° F., and examined for cracking or change of form.

*Tensile Strength.*—Briquettes of neat cement are to be made with the proportion of water used in the test for time of setting, worked strongly with the trowel for 5 minutes. The moulds are to be filled by pressing the cement in with the trowel, then tapped lightly on the sides to soften the mixture and disengage air bubbles. The surface is then smoothed off with a flat knife blade. The moulds are removed when the cement is set, and the briquettes kept for 24 hours in moist air, then put in water. Temperature to remain constant as given above. Tests are to be made at 7 days, 28 days, and 12 weeks. The tensile strength at 7 days must be at least 20 kilog. per sq. cm. (284 lb. per sq. in.); at 28 days, 35 kilog. per sq. cm. (497 lb. per sq. in.); at 12 weeks, 45 kilog. per sq. cm. (639 lb. per sq. in.). The tensile strength at 28 days must exceed that at 7 days by at least 5 kilog. per sq. cm. (71 lb. per sq. in.); the tensile strength at 12 weeks must be greater than that at 28 days unless the latter shall be at least 55 kilog. per sq cm. (781 lb. per sq. in.)

Sand tests are to be made with three parts sand by weight, with 12 per cent. water. The sand to be used is *crushed quartz* from the Cherbourg quarries, passing a 20 mesh and remaining on a 30 mesh sieve. The moulds are filled by pounding with a spatula of prescribed size and weight, as in the German requirements. The tensile strength with three parts sand must be at 7 days at least 8 kilog. per sq. cm. (114 lb. per sq. in.); at 28 days at least 15 kilog. per sq. cm. (213 lb per sq. in.); and at 12 weeks 18 kilog. per sq. cm. (256 lb. per sq. in.) The strength at 12 weeks must in all cases be greater than that at 28 days.

### NOTES ON THE FOREGOING METHODS OF TESTING.

The report of the Committee of the Society of Civil Engineers contains the following very just paragraph:

* "Portland Cement und seine Anwenduugen im Bauwesen," Berlin, 1892, p. 36.

* In an ordinary Fairbanks testing machine the actual weight used is multiplied by 100. According to this the time required to break a briquette should be about five seconds for every 100 pounds of tensile strength.

† Candlot, "Ciments et Chaux Hydrauliques," Paris, 1891, p. 150.

"The testing of cement is not so simple a process as it is sometimes thought to be. No small degree of experience is necessary before one can manipulate the materials so as to obtain even approximately accurate results. The first tests of inexperienced, though intelligent and careful, persons are usually very contradictory and inaccurate, and no amount of experience can eliminate the variations introduced by the personal equations of the most conscientious observers. Many things, apparently of minor importance, exert such a marked influence upon the results that it is only by the greatest care in every particular, aided by experience and intelligence, that trustworthy tests can be made."

It is undoubtedly true that engineers often belittle and neglect necessary precautions in testing cement. Far too many have their own special methods, often giving quite unfair results, and pay little attention to the suggestions and warnings of experts who have gone deeply into the subject. On the other hand, it is not to be expected that practical cement testers will follow the exact methods and employ the delicate instruments needed for scientific research. Simple and plain methods must be devised, and no precautions insisted upon which do not certainly and greatly affect the results. The following notes, taken from the writer's own experience, are offered in the interest of simplicity and uniformity in methods of testing.

*Fineness of Grinding.*—It is well known that only the finest dust of cement has any great setting and hardening power; the coarser particles, even those passing a fine screen, but gritty in feeling and dark in color, act merely like sand. For this reason, the finer the sieve used in testing, the more significant the results will be. A cement might, for example, be so ground as all to pass an 80 mesh sieve, and yet contain but little dust. Of two cements, the one showing the largest residue on an 80 mesh sieve might contain the larger proportion of dust, and be really the better ground.

The following table, taken from the records of the laboratory for cement testing at Cornell University, shows the results which several cements gave when tested with sieves of different grades.

*Percentage Remaining on Various Sieves.*

| Meshes per inch. | Meshes per square inch. | Dykerhoff (German). | K. B. & S. (English). | White's (English) | American. | American. |
|---|---|---|---|---|---|---|
| 50 | 2,500 | 0·6 | 10·8 | 7·2 | 4·3 | 0·5 |
| 80 | 6,400 | 6·2 | 12·5 | 10 8 | 10·1 | 14·1 |
| 180 | 32,400 | 23·5 | 14·3 | 14·9 | 19·4 | 26·0 |
| Dust. | .... | 62·7 | 62·4 | 67·1 | 66·2 | 59·4 |

It will be seen that the first and last of these cements, though giving the best results when tested with a coarse screen, are really inferior to the others in actual pescentage of impalpable powder.

The presence of a few per cent. of coarse material, or the addition of a few per cent. of sand, actually *increases* the tensile strength of neat cement With two or three parts sand, however, the superiority of well ground cement appears most strikingly, the results being nearly in proportion to the amount of fine dust present. It should be remembered, however, that soft, light-burned cements are much more easily ground fine than those which are hard and well burned. The fineness should therefore be considered in connection with the results of other tests.

*Color, etc.*—The color of a cement is often considered as an indication of its quality. This is only partially correct. Cements are light or dark according to the amount of iron present in the materials, a mixture rich in iron oxide giving a dark cement, while materials nearly free from iron give a light colored product. Some of the best German cements are, however, decidedly dark. A brown tint in Portland cement generally indicates too light burning or defective combination of the iron from other causes. Natural rock cements, which are very lightly burned, are all more or less brown. The color of cement after hardening in water is important, as the occurrence of brownish patches indicates poor quality. A dark bluish-green color is sometimes seen on the back of pats of cement which have hardened on glass or in the interior of freshly broken briquettes. This is due to the presence of sulphides, due to too much sulphate of lime in the materials, combined with bad burning. Such cement gives weak tests, especially with sand.

*Constancy of Volume.*—The tendency of cement to expand or crack is the most dangerous of all the faults it can show, since this may in time cause the destruction of the work in which the cement is used. The pat test on glass is generally relied upon to detect this fault, and should never be omitted. Care should be taken not to put the pats in water until thoroughly set, as the best cements will fail if put in water too soon. For the sake of uniformity it is best to keep the pats for 24 hours under a damp cloth or in a closed box before putting in water. The amount of water used in mixing should not be too great, or the cement will not harden well. The amount specified in the German requirements will be found suitable. The cracks due to expansion occur usually at the edges of the pat, and radiate from the center. These should not be confused with irregular shrinkage cracks, which show themselves when the pats are made too wet and allowed to dry out too much during setting.

The tendency to expand and crack shows itself much sooner and more distinctly in the pats than in briquettes. Nevertheless the inspection must be continued for a long time, if all possibility of future failure is to be avoided. The writer has known cases in which the pats stood satisfactorily for two weeks or more, but briquettes of the same cement went to pieces after several months. The dangerous expansion of cement is due to free or imperfectly combined lime, resulting generally from coarseness or imperfect mixture of the raw materials. The slaking of this lime is often very long delayed, but finally takes place with irresistible force, completely destroying the hardened cement and the work done with it.

For the purpose of quickly determining any tendency of cement to expand and crack, the *hot test* is largely used. This consists in exposing the pats, after setting, to the action of steam for several hours, then placing them in boiling water for some hours more. Capt. W. W. Maclay, chief of the New York Department of Docks, has lately made a study of this test; a full description of the method he recommends is to be found in the Proceedings of the American Society of Civil Engineers, October, 1892. Capt. Maclay advises placing several pats in steam; one freshly made, one after setting, and two at longer periods; after three hours' exposure to steam, each is kept in boiling water for twenty-one hours. The action of steam quickly slakes the free lime, if present, causing the pats to swell, crack, and often to fall to powder. This test has been wholly rejected by the association of German cement makers, on the ground that it is too severe, since many cements which fail under this test prove faultless in use, even after long periods. This is doubtless more or less true, and yet the hot test errs on the side of safety, and is a valuable aid to the engineer in detecting distinctly dangerous cements. The writer believes that three hours' exposure to steam is amply sufficient for all practical purposes, and that the boiling water test is unnecessary. A few trials will convince any one that no cement which cracks in cold water, even after months, can possibly stand the test in steam for three hours. The fact is that no cement is wholly free from uncombined lime, and that a very small percentage of this is entirely harmless. Such a proportion as would be dangerous in practical work is immediately and strikingly detected by the test in steam, and much more surely than by long tests in cold water.

In using the hot test, care should be taken not to make the pats too wet, since excess of water causes even the best cements to swell up and soften under the action of hot steam. The writer has found that exposure to steam after setting is a more searching test than that of placing in steam as soon as made. In the latter case slaking of the free lime appears often to take place before the setting, and the fault thus escapes detection. Pats of sound cement placed in steam after setting will harden rapidly, and show no cracking or crumbling; they will also generally remain attached to the glass, though this point is usually not regarded as essential, since the best cements vary greatly in this respect.

*Tensile Strength.*—Many engineers depend entirely on tensile strength tests in judging of the quality of a cement, and confine their tests to those of neat cement at short periods. This is not good practice, for several reasons. Cements which are very high in lime, and even those showing a tendency to crack, often give remarkable neat tests at short periods. The highest one-day and seven-day breaks the writer has ever seen were given by cements which went entirely to pieces at 28 days, and failed utterly in the hot test. Such cements always give very low results when tested with three parts of sand. Neat tests are in all cases more or less deceptive, since many cements which give very poor results with sand pass the neat test without difficulty. For this reason, the only test officially recognized in Germany is the test with three parts sand at twenty-eight days. Neat tests, if made, should always be taken in connection with pat tests for constant volume, since the latter will show whether the strength of the cement at short periods is legitimate or not. The *best cements*, as shown by their reputation, are not those which give astonishing breaks at one or seven days, but are rather those which show a fair strength at first, and a steady gain through long periods. The demand for high breaks within the first few days has led manufacturers to raise the percentage of lime in their cements to the highest possible point, since only in this way can such tensile precocity be secured. This brings them near the danger line, however, and opens the way to defects of the gravest kind.

In making briquettes, a number of precautions must be observed, or the results will be wholly misleading.

The proportion of water used greatly affects the resulting strength. Enough water should be taken to make a stiff, plastic mixture; more than this weakens the briquettes, especially when tested at short periods. For quick setting natural rock cement, about 30 per cent. of water will generally be required. Portland cement requires from 22 to 25 per cent. With three parts sand, water to the amount of 10 per cent. of the weight of the mixture, as specified in the German requirements, will be found about correct. In work so necessarily exact as this, the use of French weights and measures will be found an immense saving of labor and tedious calculation. The cement and sand are weighed in grammes and the water measured in cubic centimeters. Since one cubic centimeter of water weighs one gramme, the correct percentage may at once be taken without calculation.

The temperature of the testing room, the water used for mixing, and the water in which the briquettes are kept, greatly influence the results, especially at short periods. Cement which shows 150 lb. in one day when briquettes are made and kept in a fairly warm room may easily show as low as 50 lb. when made and set in a room near the freezing point. A constant temperature of 70° or thereabout is essential.

The thoroughness of mixing the cement and water makes a most surprising difference. The German requirements specify that the mixture for sand briquettes shall be "strongly worked with the trowel for five minutes." The writer found, in one case, that a cement with 3 per cent. of sand, worked about one minute, gave at seven days 87 lb.; the same mixture, thoroughly worked five minutes, gave in seven days 240 lb. With neat cement thoroughness of mixing is equally necessary. Doubtless, many failures and variations in results are due to neglect of this precaution. Rubbing the moist mixture in a large porcelain mortar for a few moments before filling each mould is practiced by some. This method gives higher results, and, if adopted, should be uniformly followed.

The manner of filling the moulds, also, greatly affects the results. In the writer's opinion, briquettes of neat cement should be made by pressure of the thumbs alone, rubber finger caps being worn for protection. The mixture should be stiff enough to allow a fair pressure to be applied without forcing the mortar out of the mould. This method has been found to give more uniform results than any other. Pounding the cement into the moulds is a bad practice. Very high breaks may be obtained in this way, especially if very little water be used, but the results will vary immensely with the amount of pounding, and indicate little or nothing in regard to the quality of the cement. Making the mixture very wet (25 to 26 per cent. water) and filling the moulds with the trowel alone, is recommended by many. The results obtained in this way are lower, and liable to vary greatly on account of unavoidable air bubbles. Whichever method is adopted, it should be rigidly adhered to, and the results checked by tests of cements of known good quality.

In tests with sand a certain amount of pounding is essential to the production of sound briquettes. The German and French specification of a spatula of certain size and weight is a very good one. Instead of this, a fairly heavy trowel will give good results, or a block laid on and lightly rapped with a mallet.

In regard to the kind of sand to be used, it may be mentioned that the German standard sand consists of more or less rounded grains, rough on the surface. The American standard crushed quartz is, on the other hand, composed of sharp and glossy splinters, which lie very loosely together, the air spaces between the grains being much greater than in the German standard or any other natural sand. For this reason, the American standard quartz gives decidedly lower results than an ordinary building sand. In the writer's judgment its use is objectionable on this account. A pure quartz sand, of proper fineness, is preferable for practical work, as it more nearly represents the results the cement will give in use.

*Testing Machines.*—Those in common use are of two types. In one the weight is applied by a stream of shot which runs from a reservoir into a pail suspended at the end of the steelyard arm; when the briquette breaks the arm falls, automatically cutting off the flow of shot. In the other type a heavy weight is slowly drawn along the beam by a cord wound on a wheel turned by the operator. The former type is that officially recognized in Germany and France, and is decidedly preferable on account of its greater simplicity, smaller bulk and regular application of the weight. The ponderous and costly weight machines, in which the weight is more or less jerkily propelled at any speed the operator may fancy, appear not to be used outside of this country.

An important point in any machine is the form of the jaws which hold the briquette. If made to fit closely over a considerable surface, the briquettes will be crushed, not broken, across the smallest section. The jaws should be cut away so as to touch the briquette only along a broad line on each side. A strip of tin, bent to fit inside of each jaw, is a great help in giving clean breaks at the smallest point of the briquettes.

Compression tests are not commonly made in this country, owing to the rather expensive apparatus required. They are, however, very necessary in case of work of great magnitude. The tensile strength of cement is generally assumed to indicate the compression strength with fair accuracy, as it has been found that cements of good quality usually show a resistance to compression equal to about ten times the tensile strength on a given section. In quick-setting and natural rock cements the compression strength is relatively lower.

*Apparatus Needed for Testing Cements.*—The following may be considered a fair equipment for ordinary tests:

A slab of slate or marble, at least two by three feet in size, one and a half inches thick.

A grocer's scale, weighing to one-fourth ounce.

Set of weights, preferably on the metric system.

A glass graduate for measuring water, preferably showing cubic centimeters.

A trowel with five-inch blade.

Pieces of glass, about five inches square, for pats, and some about three inches square for hot tests.

Testing machine and at least one dozen moulds.

A trough for keeping briquettes in water, best lined with zinc.

A square copper box on legs for hot tests, with gas burner, rack for pats, and cover.

## SPEED VERSUS ECONOMY IN STEAM VESSELS.

AT a recent meeting of the Institution of Mechanical Engineers, London, a paper was read in regard to the efficiency of marine engines and boilers by Prof. T. Hudson Beare.

The research committee on marine engine trials of this Institution has been for some time past engaged in making trials with different steam vessels. Six vessels have been experimented upon altogether since the committee was formed. These ships have consisted of channel passenger vessels and cargo boats, the committee not having had yet an opportunity of experimenting upon an important ship of the ocean liner type.

The labors of the committee have been brought to a conclusion for the present at any rate; and the paper of Prof. Hudson Beare was intended to give a summary of the results and afford a basis of discussion thereupon. We are at a loss, says *Nature*, how to condense within the compass of space at our disposal the mass of data dealt with by the author of the paper. Perhaps the most lasting impression on one's mind, after going through the subject, is that no general conclusions that can be compactly expressed are to be drawn from the trials. The conditions of work required from marine engines in ships of different classes are so various that what is paramount virtue in one case becomes an unnecessary refinement in another. Thus in the cargo boats the first consideration is economy in fuel, to which nearly every other feature in the machinery is usually sacrificed. In order to carry cargo at a rate sufficiently low to enable the shipowner to compete, the coal bill must be light, and therefore we find in these vessels boilers lightly worked and speeds low. On the other hand, vessels that have to convey passengers must be speedy, and general economy has to be sacrificed to this end, the model of the vessels themselves being formed with the same purpose in view. Perhaps we cannot do better than quote some of the elements of design of the machinery and some of the results attained during the trials, in order to illustrate these leading facts.

We will take two of the ships tried—the Iona, a large cargo boat, and the Ville de Douvres, a paddle boat carrying mails and passengers between Dover and Ostend. The Iona is 275 ft. long, 37·3 ft. wide, 27 ft. 7½ in. draught and 4,430 tons displacement. Her speed

on trial was 8·6 knots. The Ville de Douvres is 271 ft. long, 29 ft. wide, 9 ft. draught and 1,090 tons displacement. On her trial she made 17·1 knots. It will be seen, therefore, that the cargo boat is considerably over four times the displacement, and travels at about one-half the speed of the mail boat. As both craft are approximately the same length, the additional size and weight-carrying capacity of the Iona is made up by her greater beam and also by her fuller ends. The engines of the Iona are of the three stage compound, popularly but erroneously known as triple expansion engines. As a matter of fact, the Iona's engines are 19 expansion, the steam being expanded nineteen times in passing through the three cylinders. The Ville de Douvres has ordinary two cylinder compound engines, in which the steam is expanded but 5 7 times. The horse power required to drive the 4,430 tons of the bluff-ended Iona through the water was but 645·4 indicated, while the Ville de Douvres, modeled for speed, required 2,977 indicated horse power to enable her to get her 17 knots. Supposing each unit of power to be obtained in both ships at an equal expenditure of fuel, the figures quoted will show the price that has to be paid for speed; but there is a further item to the debit side of the coal bill in the case of the fast ship. In order to get high speed it is very desirable, indeed necessary, that machinery should be light, and light machinery, other things being equal, means a low figure of merit in regard to fuel economy.

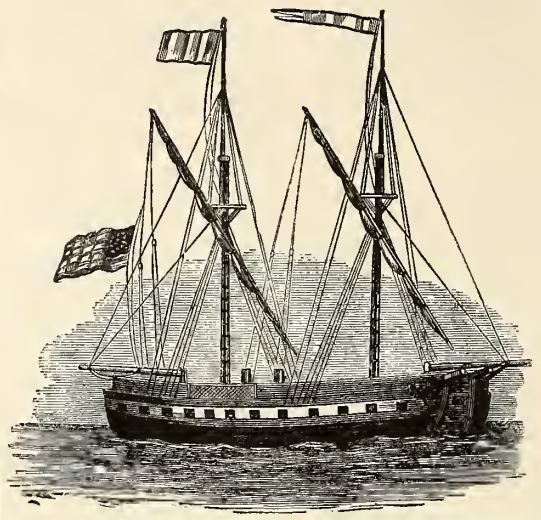
The Iona works, as stated, with 19 expansions, her boiler pressure being 165 lb. above atmosphere; while the Ville de Douvres has boilers pressed only to 105 lb. The result of this greater expansion of steam on the part of the cargo boat's engines and the easy way in which her boilers are worked enables each unit of power to be obtained on a cousumption of 1·46 lb. of coal per hour; while the Ville de Douvres required 2·32 lb. of coal for each indicated horse power exerted for an hour.

It is easy to see from these figures, which are fairly representative, that economy and speed cannot go hand in hand; the owner must select whether he would rather travel cheaply (in fuel) or quickly.

Pursuing the investigation of this branch of the subject, we find that the total weight of the machinery of the Iona is 202 tons, which gives 3·1 units of power per ton weight of machinery; while the total weight of the machinery of the Ville de Douvres was 361 tons, equal to 8·2 units of power per ton weight of machinery. With regard to space occupied, the engines of the two ships are not comparable, being paddle and screw engines respectively; but in boilers we find that the net volume required for each indicated horse power with the Iona was 4·15 cubic feet, and with the Ville de Douvres 2·09 cubic feet, thus showing that space, as well as weight, may be gained by the sacrifice of fuel economy. In the discussion which followed the reading of the paper, Mr. Jeremiah Head, of Middlesborough, gave some interesting figures in regard to those cargo steamers generally known as "ocean tramps."

He stated that the steamship Westoe, a vessel of this class, had carried 3,500 tons dead weight at a speed of 9 knots, the fuel burned being at the rate of 0·64 oz. per ton per nautical mile, or about one five-hundredth of a penny. Another ship, the Oscar II., of 4,600 tons dead weight capacity, required a consumption of half an ounce of coal per ton per mile. Still another vessel steaming at 8·9 knots showed a similar fuel economy. The figures are striking and easily remembered: half an ounce of coal for each ton carried one nautical mile.

The boilers of both the Iona and the Ville de Douvres are of a similar type, being the ordinary return tube marine boiler, but the proportions are somewhat different. Thus in the Iona the proportion of total heating surface to grate surface is 75·2 per cent.; in the Ville de Douvres it is but 31·1 per cent. This large extension of the heating surface means both a heavier and more bulky boiler, as has been shown; but in the cargo boat this sacrifice of weight and space can be profitably made in order that the fullest amount of heat from the products of combustion may be absorbed by the water in the boiler. In the Ville de Douvres this heat is allowed to pass off by the chimney. If we turn to the record of funnel temperatures, we find this fact borne out, the escaping gases in the Iona being 452° Fah. and in the Ville de Douvres 910° Fah., as far as could be ascertained. The coal consumed on a given area of grate in the two vessels does not vary greatly, it being 22·4 lb. per hour in the Iona and 31·3 lb per hour in the Ville de Douvres. The different proportions of grate to heating surface in the two ships will, however, be remembered. If we turn to the coal burned per hour per square foot of heating surface, we find it but 0·298 lb. in the Iona and 1·01 lb. in the Ville de Douvres.



THE WAR STEAMER FUL'TON THE FIRST.

With regard to evaporation, each square foot of heating surface in the Iona's boilers turned 2·73 lb. of water into steam per hour; in the Ville de Douvres the corresponding figure was 9·02. The feed water evaporated per lb. of fuel was 9·15 lb. in the Iona and 8·97 lb. in the Ville de Douvres. Taking carbon values—that is, excluding incombustible ash—and reducing the results to an equivalent of evaporation from and at 212°, we find the corresponding figures to be 10·42 lb. for the Iona and 9·94 lb. for the Ville de Douvres, a by no means bad result for the latter vessel's boilers, considering the demand made upon them in other respects.

Turning to the engines of these two ships, we find that the efficiency of the Iona's engines was 17·1 per cent., while the Ville de Douvres' engines had an efficiency of 11·7 per cent. The weight of steam used in the main engines of the former vessel was 13·35 lb. per indicated horse power per hour, while in the Ville de Douvres there were required 20·77 lb. of steam to produce one unit of power.

The figures we have quoted will be sufficient to give an idea of the scope of the paper. We have not space to go into the discussion upon the various causes of the variations in results; for these we must refer our readers to the proceedings of the Institution, where also will be found an account of the long and interesting discussion which followed the reading of the paper.

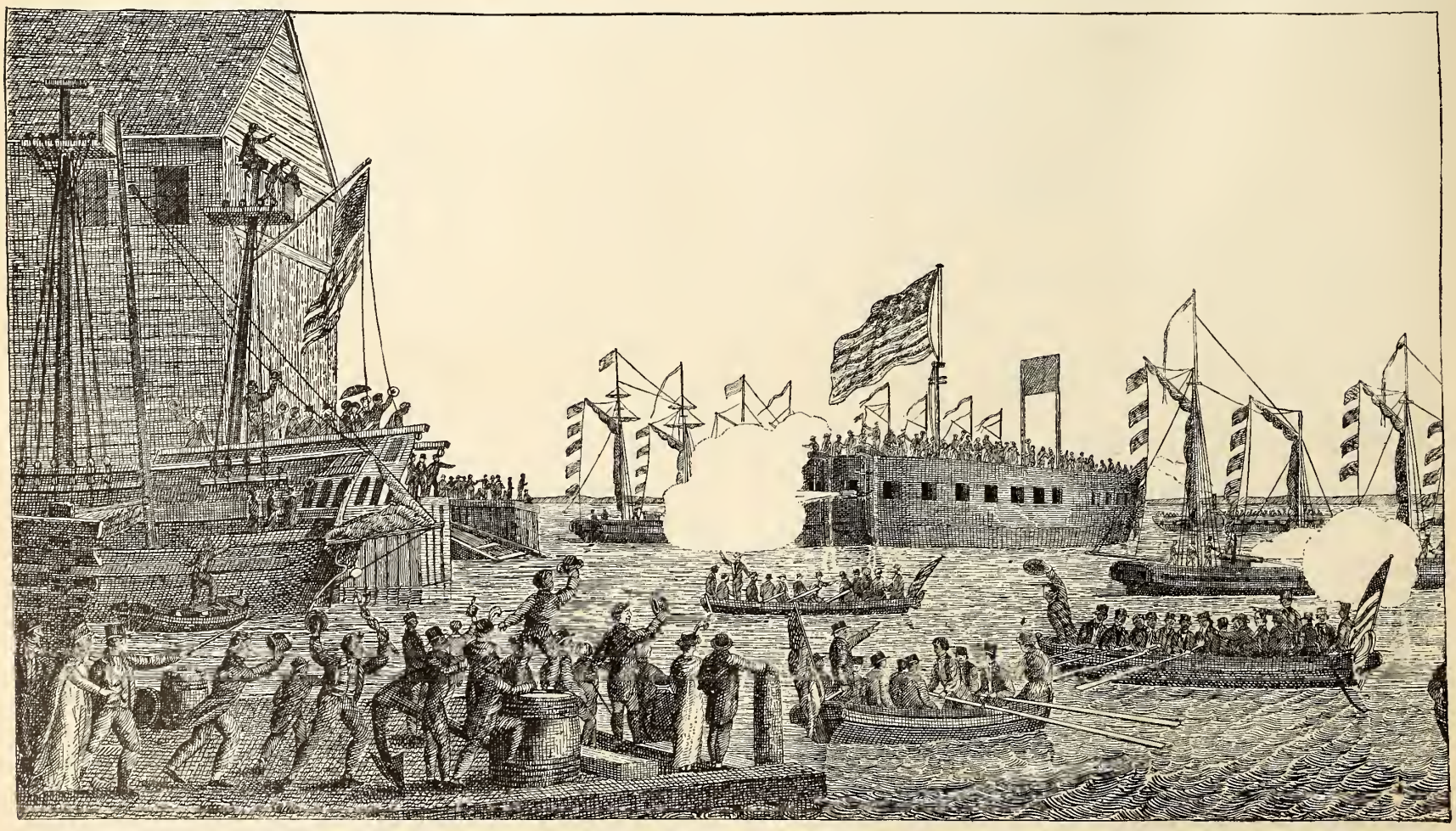
## THE FIRST WAR STEAMER OF THE WORLD.

Robert Fulton, illustrious from his connection with the early invention of steam navigation, was not content to apply his inventive and constructive genius to passenger ships alone. During the war of 1812, when our navy was making a glorious record at sea, its disproportion to the work which it had to do in protecting the great line of coast was evident. For the defense of cities and harbors, Fulton designed a steamship of war, which he called the Demologos, the first war steamer of which there is any record. Fulton's original design for the Demologos presents a double-ended ship with two keels, flat bottom, and with a gun deck and main deck. Her sides were to be 5 ft. in thickness, diminishing below the water. In her center was a well containing a paddle wheel designed for her propulsion. A single cylinder engine was to be provided to turn the shaft; the weight of the engine on one side was counterbalanced by the weight of the boiler on the other. Twenty guns were to be carried by this craft. Her length was to be 140 ft., width 42 ft. The engraving opposite represents the original sketch submitted by Robert Fulton to the President of the United States. Fulton intended it to carry a strong battery, with furnaces for red hot shot, and to be propelled by steam alone at the rate of four miles an hour. It was proposed to have submarine guns suspended from each bow to attack a ship below the water line. An engine was to have been added to discharge hot water upon the enemy to repel boarders.

By special legislation a law was passed in 1812 authorizing the construction at New York of one or more floating batteries of this description. A sub-committee of three gentlemen obtained recognition by the government as agents for the construction of the ship: Samuel L. Mitchell, Thomas Morris, and Henry Rutgers—three good New York names.

The work of construction was carried out under the direction of Fulton as engineer, and Messrs. Adam and Noah Brown, of this city, as the naval constructors. Her keels were laid in the shipyard at Corlaers Hook, on the East River, New York, on June 20, 1814, and on the 29th of the following October she was launched in the presence of many spectators. She was named the Fulton the First. We give below a view of the launch, as drawn on the spot by the artist Morgan.

Our sketch of the launch shows her safely embarked in the water, firing her bow guns, while in the distance the low shores of Long Island are visible, not showing a single house where now is the great city comprising the Eastern District of Brooklyn. As launched, she was considerably modified from the original plans. She was 156 ft. long, 20 ft. deep, and 56 ft. broad. Instead of a small well for the paddle wheel, a long channel, 15 ft. wide and 66 ft. long, was provided for it. On one side of the hull was a copper boiler, 22 ft. long, 8 ft. deep, and 12 ft. wide. On the other side was the engine with one cylinder, 48 in. in diameter and 5 ft. stroke. The paddle wheel was 16 ft. in diameter and 14 ft. wide, giving a clearance of 6 in. from the sides of the channel. It dipped 4 ft. Her tonnage was computed at 2,475 tons—a very large vessel for that period. Her hull was designed by Samuel Humphreys, of New York, and cost $144,949. The boilers and engines were designed by C. W. Copeland. The engine cost $40,199 and the boiler $93,396. Great difficulty was experienced by the commissioners in getting men to work on her. It was war times. Many of the New York shipbuilders were gone up the lakes. Material was



LAUNCH OF THE FIRST WAR STEAMER, THE FULTON FIRST, AT NEW YORK, OCTOBER 29, 1814.

very difficult to supply; guns were transported by land from Philadelphia, over the "miry roads of New Jersey," as the commissioners described them. Twenty heavy cannon were thus brought to New York. As completed she was to carry thirty long 32-pounders and two Columbiad 100-pounders. In the daily papers of these times are found a few notices of the progress of matters. Captain David Porter expresses, in 1814, the highest ideas of her capacity. He expects her to draw no more than 10 ft. with all her machinery, guns, and crew on board.

In the New York *Evening Post* of October 14, 1814, it is announced that "the Albany steamboat will postpone its trip to Albany until the Sunday following the launch." "The steamboat Williamsburg," it is announced, in the *Post* of October 28, 1814, "will accommodate such persons as may apply at the foot of Delancey Street." Finally, in the *Evening Post* of October 29, we find that "the Fulton the First was tri-

commandant of the Navy Yard, had been on board her. While in his office he heard the explosion, which seemed to him no louder than a 30-pounder. Owing to her very decayed state she was blown to pieces, although there were not more than 2½ barrels of damaged powder on board. There is no question that if she had been used in the war she would have proved a very formidable ship for those days, and would have done execution as great in degree as that done during her brief career in the civil war by the famous Merrimac.

We give a small engraving representing the appearance of the Fulton the First when finished and rigged. For this cut we are indebted to the publishers of the Memorial History of the City of New York, edited by James Grant Wilson. No description is given of the vessel, nor is any reference made as to the source from which the picture was derived. We have not been able to find an authentic portrait of the vessel,

ment on deck, she should be furnished with four submarine guns, two suspended at each bow, to discharge a hundred pound ball into an enemy ten or twelve feet below her water line, and that she should have an engine for throwing an immense column of hot water upon the decks or through the ports of an opponent. Her estimated cost was three hundred and twenty thousand dollars, which was about the cost of a first class sailing frigate.

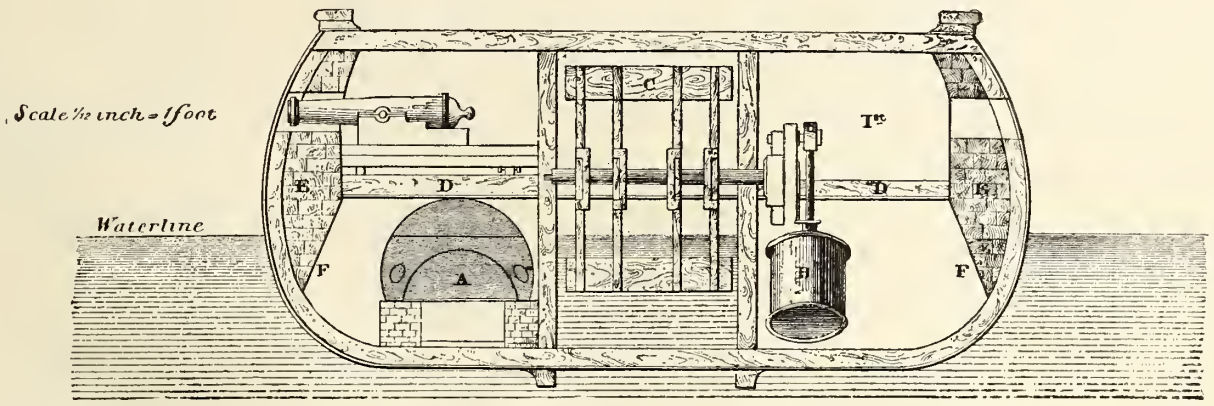
Fulton's project was favorably received, and in March, 1814, a law authorized the President to cause to be equipped "one or more floating batteries for the defense of the waters of the United States."

The construction of the vessel was committed by the "Coast and Harbor Defense Association" to a subcommittee of five gentlemen, appointed by William Jones, Secretary of the Navy.

Robert Fulton, whose soul animated the enterprise, was appointed the engineer, and on June 20, 1814, the

# "DEMOLOGOS"

Figure I[st] *Transverse section A her Boiler, B the steam Engine C the water wheel, E E her wooden walls 5 feet thick diminishing to below the waterline as at F F, draught of water 9 feet D D her gun deck*




*Scale ½ inch = 1 foot*

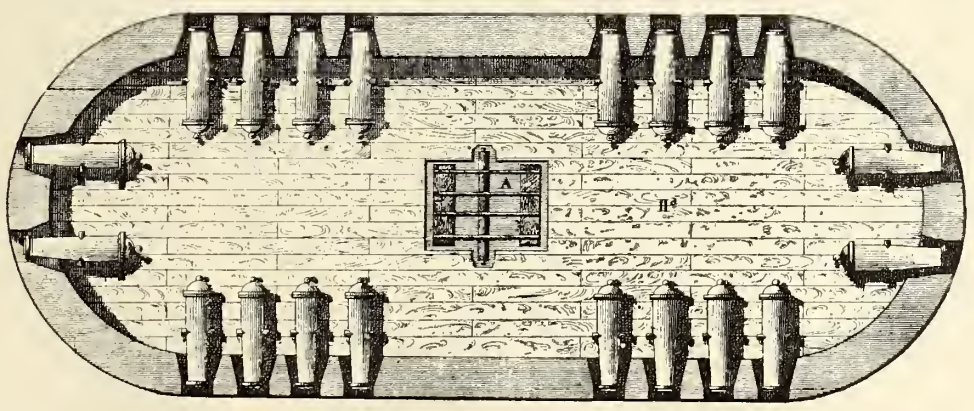
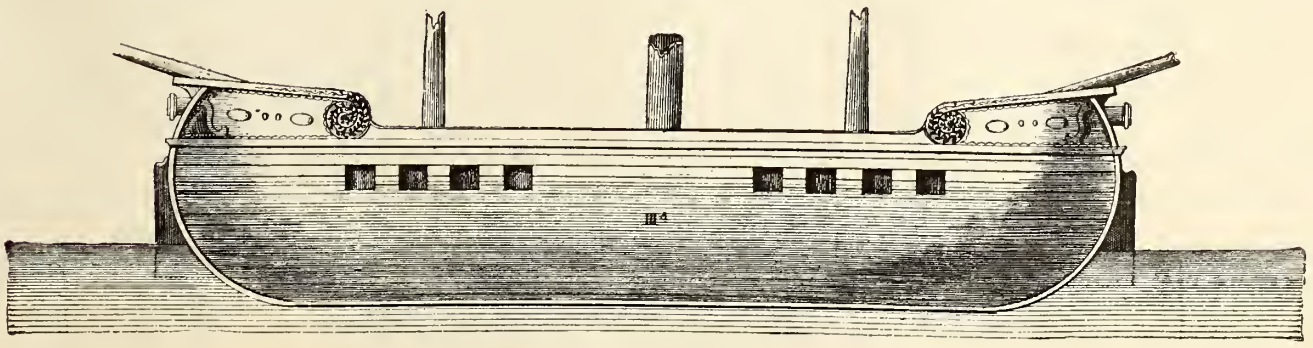



Figure II[d] *This shews her gun deck, 140 feet long 24 feet wide, mounting 20 guns A the Water wheel*

Figure III[a]
*Side View*




*Scale ½ inch = 1 foot*

## THE WAR STEAMER FULTON THE FIRST.

umphantly launched amid the roar of cannon and the shouts and acclamations of upward of 20,000 people." A 32-pounder was discharged from her deck to give warning to the people. The jar of this discharge started her down the ways a quarter of an hour ahead of time. Her subsequent career was uneventful until the end came. In June, 1815, her engine was in a condition to try her, and on the first of the month at 10 o'clock, she went down New York Bay to the Narrows, on her first trial trip. On the Fourth of July of the same year she made a 53 mile passage out on the ocean and back in 8 hours and 20 minutes, and in September she made another trial trip, going against a three mile tide at the rate of 2½ miles per hour.

The war terminating, she was moored on the flats abreast of the Navy Yard, in Brooklyn, where she was used as a receiving ship. On June 4, 1829, about 2:30 P. M., she blew up; 24 men and a woman were reported killed, 19 wounded, and 5 missing. But a few minutes before the explosion, Commodore Isaac Chauncey, except that taken on the day of her launch by Morgan.

We give a copy of the original drawings of the ship as prepared by Fulton, which we take from the "Naval and Mail Steamers of the United States," by Charles B. Stuart, published in 1853. The name proposed by Fulton for his novel craft was Demologos, a term derived from the Greek and signifying "Voice of the People."

### THE FIRST WAR STEAMBOAT.*

NEAR the close of the year 1813 Robert Fulton exhibited to the President of the United States the drawing of a proposed war steamer or floating battery, named by him the Demologos.

He contemplated, in addition to the proposed arma-

* From a paper in the *United Service Magazine* on the "Origin and Development of Steam Navigation," by the late George H. Preble, Rear Admiral, U.S.N.

*keels* of this novel steamer were laid at the ship yard of Adam & Noah Brown, in the city of New York. The blockade of our coast by the enemy enhanced the price of timber, and rendered the importation of copper, lead and iron, and the supply of coal from Richmond and Liverpool difficult; these obstacles were, however, surmounted, and the enemy's blockade only increased the expense of her construction. With respect to mechanics and laborers there was also difficulty: shipwrights had repaired to the lakes in such numbers that comparatively but few were left on the seaboard; besides, a large number had enlisted as soldiers. By an increase of wages, however, a sufficient number of laborers were obtained; and the vessel was launched on October 29, 1814, amid the hurrahs of assembled thousands.

The river and bay were filled with steamers and vessels of war in compliment of the occasion. In the midst of these was the floating mass of the Demologos, or Fulton, as she was afterward named, whose

bulk and unwieldly form seemed to render her as unfit for motion as the land batteries which were saluting her.*

Captain David Porter, writing the Secretary of the Navy under date New York, October 18, 1814, says: "I have the pleasure to inform you that the Fulton the First was this morning safely launched. No one has yet ventured to suggest any improvement that could be made in the vessel, and, *to use the words of the projector, 'I would not alter her if it were in my power to do so.'*

"She promises fair to meet our most sanguine expectations, and I do not despair in being able to navigate in her from one extreme of the coast to the other. Her buoyancy astonishes every one. She now draws only eight feet three inches of water, and her draught will be *ten* feet with all her guns, machinery, stores, and crew on board. The ease with which she can now be towed by a single steamboat renders it certain that her velocity will be sufficiently great to answer every purpose, and the manner it is intended to secure her machinery from the gunner's shot leaves no apprehension for its safety. I shall use every exertion to prepare her for immediate service. Her guns will soon be mounted, and I am assured by Mr. Fulton that her machinery will be in operation in about six weeks."

On November 21, 1814, the Fulton was moved from the wharf of Messrs. Brown, on the East River, to the works of Robert Fulton, on the North River, to receive her machinery. The steamboat Car of Neptune made fast to her port and the Fulton to her starboard side, towed her to her destination at the rate of three and a half to four miles per hour.†

The dimensions of this, the *first war steamer*, were: Length, 150 feet; breadth, 56 feet; depth, 20 feet; water wheel, 16 feet diameter; length of bucket, 14 feet; dip, 4 feet; engine, 48 inch cylinder, 5 feet stroke; boiler, length 22 feet, breadth 12 feet and depth 8 feet. Tonnage, 2,475. She was the largest steamer by many hundreds of tons that had been built at the date of her launch.

The commissioners appointed to examine her in their report say: "She is a structure resting upon two boats, keels separated from end to end by a canal fifteen feet wide and sixty-six feet long. One boat contains the caldrons of copper to prepare her steam. The vast cylinder of iron, with its piston, levers and wheels, occupies a part of its fellow; the great water wheel revolves in the space between them; the main or gun deck supporting her armament is protected by a bulwark *four feet ten inches thick, of solid timber*. This is pierced by thirty port holes, to enable as many 32 pounders to fire red hot balls; her upper or spar deck, upon which several thousand men might parade, is encompassed by a bulwark which affords safe quarters. She is rigged with two short masts, each of which supports a large lateen yard and sails. She has two bowsprits and jibs and four rudders, two at each extremity of the boat; so that she can be steered with either end foremost. Her machinery is calculated for the addition of an engine which will discharge an immense column of water, which it is intended to throw upon the decks and all through the ports of an enemy. If, in addition to all this, we suppose her to be furnished according to Mr. Fulton's intention, with 100 pounder columbiads, two suspended from each bow, so as to discharge a ball of that size into an enemy's ship ten or twelve feet below the water line, it must be allowed that she has the appearance at least of being the most formidable engine of warfare that human ingenuity has contrived."

Such is a correct description of this sea monster of 1814, but exaggerated and fabulous accounts of her got into circulation. Among others, the following was published in a Scotch newspaper, the writer stating that "he had taken great care to procure full and accurate information."‡

"Her length," he writes, "on deck is *three hundred feet;* thickness of sides, *thirteen feet*, of alternate oak plank and cork wood; carries 44 guns, four of which are one hundred pounders; and further to annoy an enemy attempting to board can discharge one hundred gallons of boiling water in a minute, and by mechanism brandishes *three hundred cutlasses* with the utmost regularity over the gunwales; works also an equal number of heavy iron pikes of great length, darting them from her sides with prodigious force, and withdrawing them every quarter of a minute."

The stores of artillery at New York not furnishing the number and kind of cannon she was to carry, guns were transported from Philadelphia, a prize having placed some excellent pieces at the disposal of the Navy Department. To avoid the danger of their capture, twenty of these guns were sent over the miry roads of New Jersey dragged by horses.

In consequence of the exhaustion of the treasury and temporary depression of the public credit, the commissioners were instructed to pay the bills for the Fulton in treasury notes, but solely at par. These notes were often so long withheld that those who had advanced materials and labor were importunate for payment, and the commissioners had frequently to pledge their private credit. Once the men discontinued work. From these causes her completion was retarded until winter, and also by the unexpected death of Mr. Fulton, on February 24, 1815.

All difficulties at length being surmounted, the machinery was put in motion, and she made her first trial trip on June 1, 1815, only nine months after her keels were laid. On this trial she was found capable of opposing the wind, of stemming the tide, of crossing currents, and of being steered among vessels riding at anchor, though the weather was boisterous and the water rough. Her performance demonstrated the success of Fulton's idea, and that a floating battery composed of heavy artillery could be moved by steam.

She left the wharf near the Brooklyn ferry, propelled by steam alone, against a stiff south breeze (which was directly ahead) and a strong ebb tide, and steamed by the forts, saluting them with her guns, her speed equaling the most sanguine expectations.

After circumnavigating the bay and receiving a visit from the officers of a French ship of war, she came to anchor at Powles' Hook ferry about 2 P. M., nothing occurring to mar the pleasure or success of the trip. It was discovered, however, that alterations were necessary, some errors to be corrected, and some defects to be supplied, before she was prepared for a second trial.

On July 4, 1815, she again made a trip to the ocean, eastward of Sandy Hook, and back again, a distance of fifty-three miles, in eight hours and twenty minutes, without the aid of sails, the wind and tide being partly favorable and partly against her, the balance rather in her favor. The gentlemen who witnessed this experiment without exception entertained no doubt as to her fitness for the intended purpose. Expedients were sought to increase her power, and devised and executed for quickening and directing her movements.

A third trial of her powers was attempted, on September 11, with twenty-six of her long and ponderous guns and a considerable quantity of ammunition and stores on board. Her draught of water was less than eleven feet. She changed her course by reversing the motion of her wheels, without the necessity of putting about, like the ferry boats of the present day. She saluted as she passed the forts, overcame the resistance of the wind and tide in her progress down the bay, and performed beautiful maneuvers around the United States ship Java, then at anchor near the lighthouse. She moved with remarkable celerity, and was perfectly obedient to her double helm. The explosion of powder produced very little concussion on board, and her machinery was not affected by it in the slightest degree. Her progress during the firing was steady and uninterrupted. On the most accurate calculation, her velocity was four and a half miles an hour, and she made headway at the rate of two miles an hour against the ebb of the East River, running three and a half knots. The day's exercise was satisfactory to the company on board beyond their most sanguine expectation, and it was universally conceded that the United States possessed a new auxiliary against every maritime invader. The city of New York was considered as having the means of making itself invulnerable, and that every bay and harbor of the nation might be protected by the same tremendous power. Her performance more than equaled Fulton's expectations, and it exceeded what he had promised the government—that she should be propelled by steam at the rate of from three to four miles an hour.

The commissioners who superintended her construction congratulated the government and the nation on the event of this noble project, and said: "Honorable alike to its author and its patrons, it constitutes an era in warfare and the arts. The arrival of peace indeed has disappointed the expectations of conducting her to battle. That best and conclusive act of showing her superiority in combat has not been in the power of the commissioners to make.

"If a continuance of tranquillity should be our lot, and this steam vessel of war be not required for the public defense, the nation may rejoice in the fact we have ascertained as of incalculably greater value than the expenditures, and that if the present structure should perish, we have the information, never to perish, how, in any future emergency, others may be built. The requisite variation will be directed by circumstances."

The war having terminated, Fulton the First, after these trial trips, was taken to the navy yard at Brooklyn and moored on the flats abreast of that station, where she was used as a receiving ship until June 4, 1829, fifteen years after the laying of her keels, when she was accidentally or purposely blown up.

Commodore Chauncey, reporting this catastrophe, says that he had been on board of her all the morning inspecting the ship and men, particularly the invalids, who had increased considerably from other ships, and whom he had intended asking the department's permission to discharge, as of little use to the service. He had left the ship but a few moments before the explosion took place. The report did not appear to him louder than a 32 pounder, although the destruction of the ship was complete and entire, owing to her very decayed state. There was on board at the time no more than two and a half barrels of damaged powder, kept in the magazine, for the morning and evening gun. By this explosion, however, twenty-four men and a woman were killed, nineteen wounded, and five reported as missing and probably killed. Among the killed was Lieutenant S. M. Breckinbridge, and among the wounded Lieutenant C. F. Platt, who died a captain in the navy, Lieutenant A. M. Mull, and Sailing Master Clough; Lieutenant Platt was dangerously, the others severely, wounded. Four midshipmen were among the wounded.

Commodore Chauncey was of opinion that "the explosion could not have taken place from accident, as the magazine was as well or better secured than the magazines of most of our ships; yet it is difficult to assign a motive to those in the magazine for so horrible an act as voluntarily to destroy themselves and those on board, yet if the explosion was not the effect of design, I am at a loss to account for the catastrophe."

Master Commandant John T. Newton,* her commander, was on shore at the time of the explosion. Such was the beginning, end, and uneventful history of the first steam vessel of war ever put afloat—the pioneer, and to an extent the model also, of the floating batteries, double-hulled vessels, and "double-enders" which have succeeded her.

Captain E. C. Bowery, U. S. N., a surviving officer of the Fulton, writing me under date December 13, 1881, says: "I say the destruction of the Fulton was by carelessness. I believe in Divine Providence, but not in accident. I joined her in the early part of 1826 as an acting midshipman, Commander Budd then having command. Her magazine (if it could be called one) was nearly under the ship's coppers, and separated only by a light bulkhead was the 'bag room,' in which the sergeant of marines had a writing desk, on which was a naked oil lamp. Soon after reporting, I had occasion to go down there; the bulkhead had a sliding door, which was open, and his lamp shone on the kegs of powder, one of which was without a head. I remarked to the sergeant, 'If your light was only five feet nearer (all the space that separated it from the powder) there would be trouble.' 'Yis,' said he, turning his beery eyes on me, "there would be a sensation.' After that I never turned in at night without thinking there might be a sensation before cock crowing, and to this day I have not forgot the appearance of that powder with the light shining on it, and draw the inference that gross carelessness caused the sensation. Yet at the time there was a story that a gunner's mate had been disrated and punished with the cats the morning before the blowing up of the Fulton."

George H. Preble,
*Rear Admiral, U.S.N.*

(*To be continued.*)

* I have seen a large copper plate engraving of the launch of the Fulton. It is entitled "Launch of the Steam Frigate Fulton the First, at New York, Oct. 29, 1814; one hundred and fifty feet long, fifty-seven feet wide, mounting thirty long 32 pounders and two 100 pounders (columbiads). Philadelphia: published March 27, 1815, by B. Tanner, 74 South Street. Drawn by I. I. Baralet, from a sketch by Morgan, taken on the spot."

† "Rees' Encyclopedia" states she was towed on this occasion by the Paragon, of three hundred and thirty-one tons burden, at the rate of four miles an hour. That she was towed by Car of Neptune and Fulton is, I believe, correct.

‡ Stuart's "War and Mail Steamers" has accurate drawings of the Fulton from the originals.

* Captain Newton also commanded the Missouri when she was burned in Gibraltar Bay, 1844.

## THE NAME OF ROBERT FULTON FOR A WAR STEAMER.

We elsewhere illustrate and describe a famous war ship, the Fulton the First, built in 1814. With her sides impenetrable by the artillery of those days, with her machinery and boilers in great part below the water line, and her paddle wheel in her center, she was in those days an almost invincible craft. It is on record that she excited the apprehensions of the British government, the most extraordinary qualities of destructiveness being attributed to her. As it happened, she never had a chance to figure in war, the treaty of Ghent and its results being communicated about the time of her completion.

She appears as the first steam man-of war ever built. She is really the corner stone of the navy to day, and in her Fulton may be said to hold an undisputed priority. It seems fitting that this country should in some way acknowledge his work. In the English navy, the names of ships are hereditary. After one ship has passed out of service, a second one, naturally of improved construction, will be built, and to her will be awarded the name of her predecessor. In this way, one after the other, a long and honorable lineage under the identical name may be established. After the destruction of the Fulton the First our navy made a second essay in the construction of a war steamer, and in 1837 and 1838 a ship was built, propelled by steam and fitted with sails, which was termed the Fulton the Second. She was provided with protective wooden bulwarks, beveled as far as possible to cause the enemy's shot to glance off. Although she made a trip to the West Indies and back, she was not designed nor suited for use in ocean work. The well known Charles H. Haswell was her chief engineer. Subsequently, in 1851, this ship was rebuilt and was termed the Fulton the Third.

In our present steam navy Robert Fulton should receive due commemoration as its founder. His name should be given to our most advanced ship, and it should be understood that hereafter, as such ship would pass out of service or would fall from the first rank, the name should pass to the best ship in the navy.

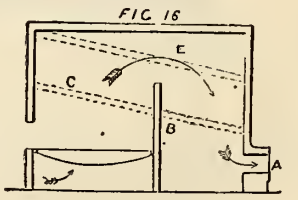
[Continued from Supplement, No. 954, page 15246.]

## WATER TUBE BOILERS.*

It matters nothing how well arranged a tubulous boiler may be in the way of providing for circulation of the water and the supply of dry steam, it cannot give satisfaction unless it is properly heated. Now, it is in some senses unfortunate that the water tube boiler may be heated not in one way but in many; while the fire tube boiler can really be heated in only one way. Take, for example, a locomotive boiler. The furnace is a box, the sides and roof of which are admirably situated for taking up radiant heat, while the products of combustion can only find their way by one route to the chimney. But the tubulous boiler has no fire box, and no special route definitely marked out for the escape of the products of combustion; and this circumstance goes far, we think, to account for the great diversity of results obtained in practice with water tube boilers. It is, then, of the utmost importance that correct views should be held on the subject. We, however, can do no more than put a few general facts and principles before our readers, who must learn to apply them in each case as can best be done.

It is very frequently assumed that if heat is generated it is of little or no importance how it is applied, the result must be the same. Theory justifies the assertion, practice flatly contradicts it. The theory is obviously erroneous. To put the matter in a more precise form, let us assume that we have a brick oven built, 10 ft. long, 5 ft. wide, and 10 ft. high. At one end is a grate, 5 ft. long and 4 ft. wide; at the end of this grate is a brick wall, 5 ft. high. The delivery to the chimney is at the same level as the grate, 4 ft. long and, say, 9 in. high. The sketch, Fig. 16, will make

FIG. 16




our meaning clear at a glance. It is evident that when a fire is lighted in the grate, the products of combustion will escape in the way of the arrows. It is taken for granted that it matters nothing how a water tube boiler is disposed within this oven, the economical and other results must be the same.

The heat is all produced inside the walls, and it cannot get out save through A. The walls are supposed to be sufficiently thick and well fitted with air spaces to prevent the escape of heat to any extent through them. Let us suppose now that we have a water tube in the position shown by the dotted line. We shall find that in practice, although that half of its length marked B is within the oven, yet as a steam generator it is almost useless, simply because the hot

* From the *Engineer*, London.

products of combustion beat down on the top of the tube. We need not stop to explain to our readers why it is that heat cannot, under such circumstances, be communicated to the pipe length, B. Again, as the hot gases will always take the shortest possible route to the chimney, they will have nothing to do with that part of the tube marked C. But there are more tubes than one. The top tube, E, is very much worse off, obviously; and by pursuing the investigation further, it will be found that the tubes are really not heated uniformly along their whole length, but only in belts or bands; and, furthermore, the radiant heat at the sides of the fire is lost. It is a mistake to assume that if it is not taken up by the tubes at once, it goes to raise the temperature of the gases. For some reason so far inexplicable, if radiant heat is not pounced upon and seized at once, it can never be got in any other form subsequently. A well known case was that of certain locomotives with very deep fire boxes which would not keep steam. The grates were raised about a foot, no other change being made, and then the radiant heat did its work on the roof and upper part of the sides of the box, and the engine steamed well. The loss of radiant heat in water tube boilers of the Root type has been so fully recognized that improvements have been effected; one firm places the furnace in a water casing, and another disposes pipes at its sides. Fig. 16*a* shows a water tube boiler with a water-cased

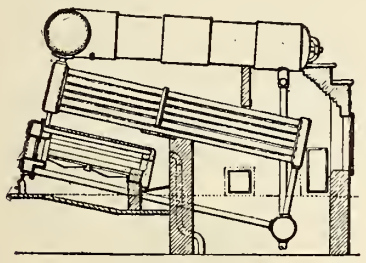
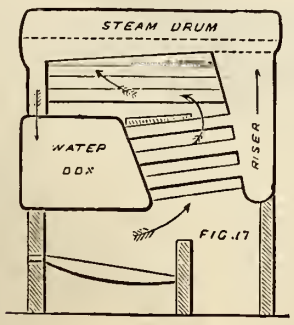


Fig. 16a

furnace. It may be of interest here to add that in an instance which came under our notice, not long since, a water tube boiler, which gave wet steam, was very uneconomical and very inefficient as well, was cured of all its faults by the simple expedient of raising the grate and making it a little longer and narrower.

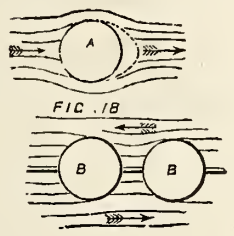
It is often urged against the Root type that it is inefficient because it makes only three or four pounds of steam per square foot of heating surface per hour. This may mean anything or nothing. All that it goes to show, in our opinion, is that there is much useless surface provided. Taking Fig. 16, it seems to be pretty clear that the pipes at the chimney side of the bridge might be greatly shortened without doing any harm. The idea involved in making these pipes so long appears to be that in no other way can economy be secured. That this lengthening of the tubes does very little good is proved by two facts. First, the De Naeyer boiler—popular on the Continent—consists really of two boilers, one placed behind the other; No. 2 being really a heater or economizer more than a boiler. Secondly, economizers can always be added with much advantage to boilers of the Root type. Bearing in mind what we have already said about distribution, every one of our readers interested in the subject will understand how much may be done with the aid of tiles laid on tubes to distribute the gases; and it ought to be found possible in all cases to avoid the down draught and carry the smoke upward, so as always to apply the heat to the under sides of the tubes. Beyond question, much of the inefficiency of the water tube boiler is due to the way in which the heat is applied. But, on the other hand, it must not be forgotten that the engineer is not always free to do what he wishes. For example, a better result would be got in the case of Fig. 16 if the pipes were shortened in length by one-third, and the same surface maintained by adding to their number and arranging them in a greater number of vertical tiers, the products of combustion always ascending between them to the chimney. But a little thought will show that the arrangement might make the whole structure too high, and that by adding unduly to the number of tiers delivering into single headers, heavy priming might be set up for reasons already explained. Again, it is wrong in principle to apply the greatest heat at the highest end of the tube. As the bubbles of steam in rising drive or push the water before them, the circulation will be more assured if the bulk of the steam is made in the lower ends of the tubes. But to this plan there may be objections. Thus, for example, it might bring the grate too near the tubes, and the furnace door might interfere with the back header. The arrangement roughly sketched in Fig. 17 shows a method of




construction for which many advantages might be claimed. Here a water box is placed over the fire to catch the radiant heat, and the hot gases pass up through the tubes, so that there is no waste surface. The objections to the scheme will suggest themselves as freely as the advantages.

On one point it is necessary to insist—it is constantly overlooked or forgotten—it is that the hot gases ought always to be caused to beat against the surface to be heated, and not allowed to run along it. Thus the plate, A, is much more efficient than the plate, B. As a rule this principle can be very freely applied in water tube boilers. Thus, if we turn to Fig. 16, it will be seen that the gases move nearly at right angles to the tubes. In the case of the Yarrow boiler they do the same, the tubes being nearly vertical and the gases moving horizontally, or at least nearly at right angles to the tubes. But circumstances may arise when a better result can be got by allowing the gases to move as in B. Because, if a vertical tube be placed in a stream of gas moving in a horizontal direction, then one side only of the tube will be heated, as in Fig. 18, the zone

A B




marked by the dotted line being nearly free from hot gas. If one pipe stands between and shelters another, the case is, of course, still worse. If the pipes are arranged as at B B, and currents of hot gas pass as shown by the arrows, then the whole or nearly the whole of the tube surface may be regarded as efficient, and the principle can be applied in practice with very excellent effect, as we hope to show when dealing with the question of reduction of weight.

Summing up, we may say that the number of ways in which the heating surface of a tubulous boiler can be arranged is almost endless, and that in very many instances the wrong arrangement is adopted, sometimes through ignorance, sometimes because advantages are secured which countervail or are believed to countervail the loss. Thus, for example, the down draught system, Fig. 16, is extremely convenient when a battery of boilers have all to deliver the products of combustion into one culvert common to them all, leading to the chimney. This makes not only a very neat arrangement, but positively, in many cases, where the boilers are working in crowded cities, the only arrangement that is possible. Where, however, it is possible to avoid them, no down draughts should be permitted. They, in all cases, represent waste of heating surface at all events. Furthermore, every effort should be made to take up the radiant heat.

One matter of very great importance must be mentioned, although the ground it covers is too large to be entered upon here. Unless care is taken, tubulous boilers will produce clouds of smoke; indeed, none of them are adapted for the use of bituminous coal. We do not say that such coal cannot be burned; we do say that we have seen so much trouble incurred in the attempt to burn it that a word of warning is necessary to those who propose using it. Abroad the difficulty has been dealt with by the adoption of step grates; but the boilers fitted with these are not pushed hard. In this country mechanical stokers, especially Jukes' grates, have been used with success; but they will not tolerate much forcing. If bituminous coal must be used, the grates and boilers should be big enough to provide all the steam needed without hurrying them. If this is not done, then smokeless—or nearly smokeless—steam coal must be provided. It should never be forgotten that the success of the mechanical stokers in keeping down smoke depends mainly on their being worked a fixed pace, maintaining constantly the same thickness of fire; and the best rate, so far as the suppression of smoke is concerned, having been got by experiment, it must be steadily adhered to subsequently.

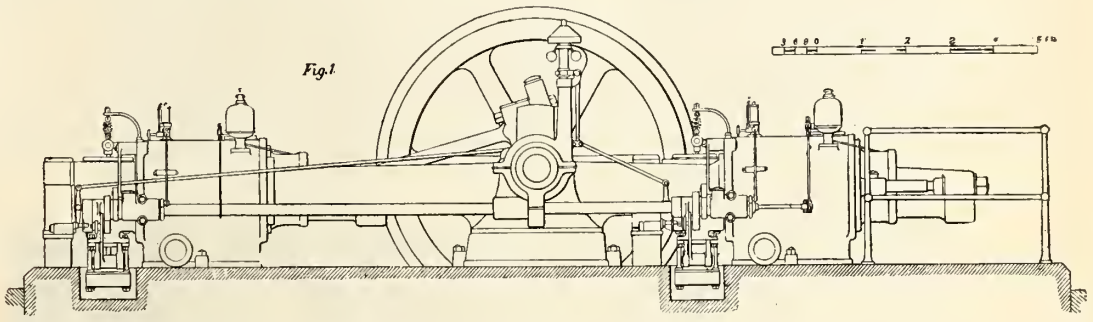
*(To be continued.)*

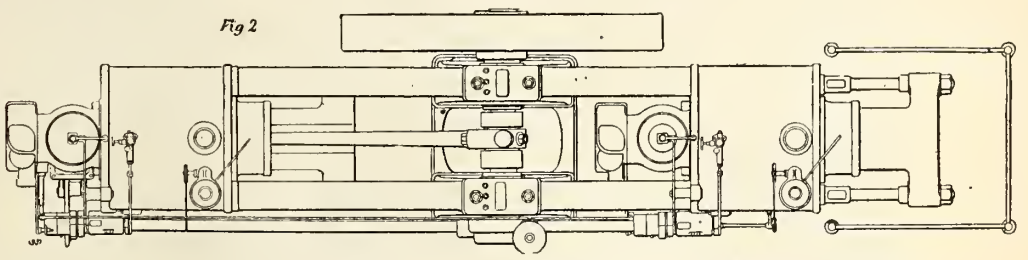
## TWO HUNDRED HORSE POWER GAS ENGINE.

THE Fielding tandem gas engine illustrated below comprises a pair of cylinders arranged end on in one line, both pistons acting in the same direction, so as to impart an impulse at each revolution at equal intervals when working at full power. The pistons are connected to each other by steel tie rods passing beneath the crankshaft, the latter being kept above the cylinder center for this purpose, and also in order to reduce the angular thrust of the connecting rod during the acting strokes. In order to relieve the piston, to which the connecting rod is attached, from the angular thrust, planed guides are formed in the engine bed to receive guide blocks formed on the piston crosshead; this is an important feature in such large engines.

The cylinders are fitted with loose liners of hard cast iron, so arranged as to allow of their free expansion independent of the jacket. The pistons are packed by five hard cast iron Ramsbottom rings, a loose junk ring being fitted, with solid intermediate rings between each pair of piston rings. Special steel miter valves of extra large area are provided for gas and exhaust, all operated by separately adjustable cams. The governor is of the high speed rotating type driven by helical gearing. The speed can be varied while the engine is running. The main valve box is a separate casting from the cyliuder jacket, secured by bolts and fitting into a bored recess in the jacket, an important feature being the avoidance of a large asbestos joint ring exposed to the heat and pressure of the explosion, as in other engines. Lubrication is attended to very carefully to enable continuous running day and night, for which these tandem engines are specially designed.

The system of self-starting used in connection with these large engines is most powerful, while it is both safe and sure in operation. By it an engine can be started against two-thirds of the load, and this without any undue shock, because it starts the engine slowly at first before the explosion takes place, so that all slack is taken up and the inertia overcome before the acting charge is ignited. It is perfectly safe, as compressed air is stored at a pressure of about 60 pounds per square inch by the action of the piston in stopping, and is used in conjunction with an ordinary self-starting apparatus. No explosion takes place except within the cylinder, as in working; the operation is the simplest possible and quite certain. The makers of the engine are Messrs. Fielding & Platt, of Gloucester.—*Engineering.*




TWO HUNDRED HORSE POWER FIELDING TANDEM GAS ENGINE.

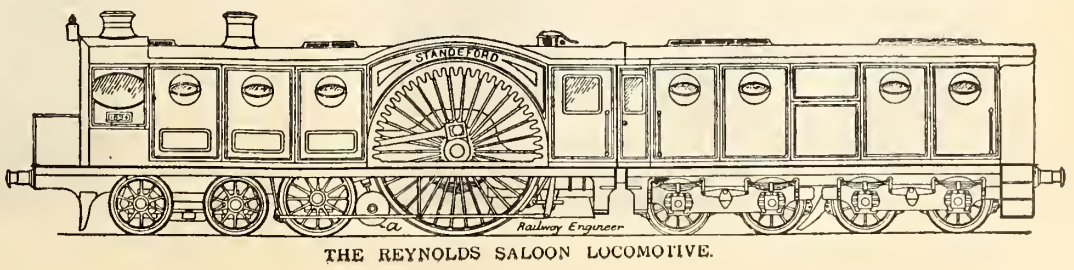
## THE REYNOLDS SALOON LOCOMOTIVE.

THE annexed sketch, which is reproduced from the *Railway Engineer* (London), illustrates the general features of the engine about which such sensational paragraphs have been appearing in the daily press of England and to some extent copied in this country.

Mr. Reynolds was for many years a driver of the Scotch and Irish mail trains; he then went to the Brighton line, which he left when he was chief locomotive inspector, so that he has a good knowledge of the working of locomotives. In connection with the drawing from which the illustration was made, Mr. Reynolds writes as follows:

In designing the Standeford, I had in view an acceleration of speed, and the ultimate possibility of the engine being called upon to do a run of 500 to 1,000 miles without a stop.

Now, as to the question of safety. More than one critic pities the road; as if one would design an engine for 80 miles an hour without thinking of the road. But the Standeford is so constructed that I venture to pre-




THE REYNOLDS SALOON LOCOMOTIVE.

dict it will be a very steady runner—steadier than any express engine now working express traffic. In the first place it stands on a long, substantial wheel base, and has three bogie carriages under it. In the next place it has three crank pins on one axle, and these are placed at an angle of 120° apart, which is obviously most conducive to easy turning effort, and practically reduces the disturbing causes to a minimum. Lastly, the employment of a big wheel reduces dead center points per mile, which, not a little, contributes to easy running and steadiness. In a seutence, the means employed are commensurate with the ends to be attained.

The outside cylinders are 18 by 30 in., and the middle cylinder 14¾ by 20 in., which drive a 10 ft. wheel. The cylinders are steam jacketed. The jackets are between the outlet and inlet steam pipe to the injectors, an arrangement which secures a circulation of steam in the jackets and draws off the condensed water.

To prevent this driving wheel slipping, under any conditions or circumstances, there is fitted a steam coupler (*a*) between it and the intermediate wheel in front, which at starting a train partially turns the engine into a four wheeled coupled. It is at starting that the maximum tractive power is required. For high speed driving-wheels are best single. We have, then, in the Standeford two classes of engines rolled into one.

As showing the drift of my purpose, to secure a steady engine the steam is not admitted to the piston until the crank is about 12° over the center, and the piston on the return stroke is gradually cushioned by compressed steam.

The firebox tube plate would be a separate plate riveted on to the front plate of the firebox, and would enter the barrel about 8 inches. A water arch would be used, and tubes of Everitt's red metal. Boiler pressure 200 lb. The water tank has a capacity of 3,000 gals., and a "pick up" arrangement would be required. The bunker holds 3½ tons of coal. A crew of three men would be carried.

It will be seen that there would be no particular difficulty about building the engine; but as to utilizing it subsequently great difficulties would undoubtedly present themselves.

As regards speeds, Mr. Reynolds writes that he aims at an average high speed of 70 to 80 miles an hour, and longer runs without stopping, and what is now done down banks he wishes to have done on the level, and kept up. He considers that an engine built to his design would accomplish this task at a less cost than 50 miles an hour now costs. He estimates the consumption of coal at from 8 to 10 lb. per mile less than any modern engine.

## DR. D'ARSONVAL'S EXPERIMENTS IN ELECTRO-PHYSIOLOGY.

The new paths opened up to electric science through the production of oscillations of great frequency have permitted the industries as well as electro-therapeutics to enter upon domains hitherto unexplored. Dr. D'Arsonval, who is particularly prepared for researches of this kind through a series of inventions in electricity, has, in this direction, pursued a course of remarkable researches in electro-physiology for which the Academy of Sciences has just awarded him the La Caze prize.

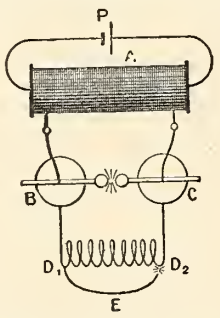



Fig. 1.—DIAGRAM OF THE APPARATUS REPRESENTED IN Fig. 2.

We shall leave the duty of treating the purely physiological part of the question to other hands, but it appears of interest to us to describe here certain extremely curious phenomena to which currents of very great frequency give rise, after briefly mentioning the apparatus that serve for obtaining them.

Dr. D'Arsonval's experiments constitute the counterpart of the remarkable ones of Mr. Tesla that are known to our readers. The latter have especially in view the production of light, while the former are important by reason of the new facts that they reveal to us upon the relation between the nerves and electricity. Mr. D'Arsonval's apparatus are simpler than those of Mr. Tesla; they are less pretentious, and produce less powerful effects, and have the advantage of being within the reach of all laboratories possessing a minimum of the apparatus classic in electricity.

Mr. D'Arsonval's first researches date from far back, and the question of physiological action of currents of

Fig. 4.—ILLUMINATION OF A LAMP BY INDUCTION UPON A RING OF WIRE.

*all frequencies* was solved in France long before the first publications of Mr. Tesla in America.

*Production and Properties of Oscillatory Currents.*—We know that, under certain conditions, an electric discharge becomes oscillatory. A very simple arrangement, the principle of which was borrowed by Mr. D'Arsonval from Mr. Lodge's experiments upon lightning rods, permits of producing this kind of discharges and of demonstrating an essential property of currents of great frequency. A Ruhmkorff coil, A (Fig. 1), serves to charge through their interior coatings two Leyden jars, B and C. The discharge that takes place between the opposite buttons is oscillatory. The potential of the external coatings varies with the same frequency, but the current, in a wire that connects them, varies more abruptly than in the circuit embracing the spark. If the external coatings be connected by a bobbin, $D_1$ $D_2$, formed of twelve spirals of coarse copper wire, they will have been put in short circuit for an ordinary current, and we could keep up a difference of a few volts between the coatings only by causing a current sufficient to volatilize it in a wink of the eye to pass into the wire. But here is wherein the oscillatory discharge shows its very peculiar character; it has an invincible repugnance to entering the wire. The reason of this is simple. The extremely rapid variation of potential that establishes itself at the terminals of the bobbin produces currents that vary with formidable rapidity, and are, consequently, possessed of enormous conductive power. The induction of each spiral acts upon the neighboring ones, and the resulting current tends at every instant to annul the primary one, so that but a feeble portion of the current passes. To calculate here the resistance, such as Ohm's law defines it, serves for nothing; we must compete with an entirely different antagonistic force combined with the resistance and induction, and which is called impedition. It is the sum of the *impedimenta* that the current finds upon its route. In the case that occupies us, the impedition is reduced practically to the force antagonizing the induction. How rebellious the oscillatory discharge is to entering the bobbin may be shown as follows: Applying a wire, E, to its extremity, $D_1$, and bringing it near the last spiral, $D_2$, there will be seen to start forth in the interval a gerb supplied with strong sparks and more than a centimeter in length (diagram and Fig. 2, details). The discharge, therefore, more easily traverses one centimeter of air than a resistance practically negligible, but possessing induction.

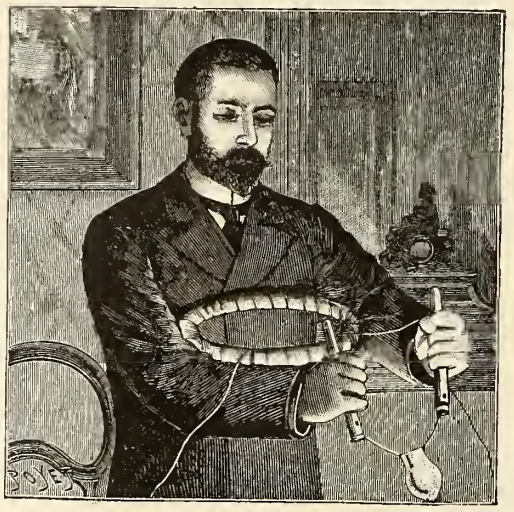


Fig. 5.—ILLUMINATION OF A LAMP BY THE CURRENTS INDUCED IN THE ARMS OF THE OPERATOR.

*Physiological Actions.*—What will happen if we touch the extremities of the bobbin? Apparently, we shall receive the entire discharge accompanied with so strong a shock that, after the example of one of the first electricians, we would not begin the experiment again for the kingdom of France. To our great surprise, we feel neither the shock nor even the slightest pricking sensation. Has the discharge changed direction again? In nowise; for if, instead of touching the bobbin at both ends, we content ourselves with bringing near one of them a piece of metal held in the hand, we shall see the sparks reappear. Furthermore, we can put an incandescent lamp in our circuit and see it become brilliantly lighted (Fig. 2). The current, then, really traverses our body without our suspecting it, thus showing another of its caprices. To what is its innocuousness due? The first idea that occurs to the mind is that the current passes entirely to the surface of the body, in the epidermis and in the clothes. In this explanatiou there is doubtless some truth, but such localization of the current is not the sole cause of its immunity. Mr. D'Arsonval's researches have shown that neuro-muscular phenomena increase in intensity with the frequency up to 3,000 alternations per second, remain sensibly stationary up to nearly 5,000 alternations and afterward decrease to become soon annulled. A frog's foot is insensible to the Hertz oscillator, as has been shown by Mr. Joubert. And yet the physiological action of these currents is far from being null. Its passage in the tissues is accompanied with singular effects: 1. If, for a certain time, the current be closed through the hands provided with wide metallic

Fig. 6.—LAMP LIGHTED IN THE HANDS OF AN OPERATOR INCLOSED WITHIN A SOLENOID.

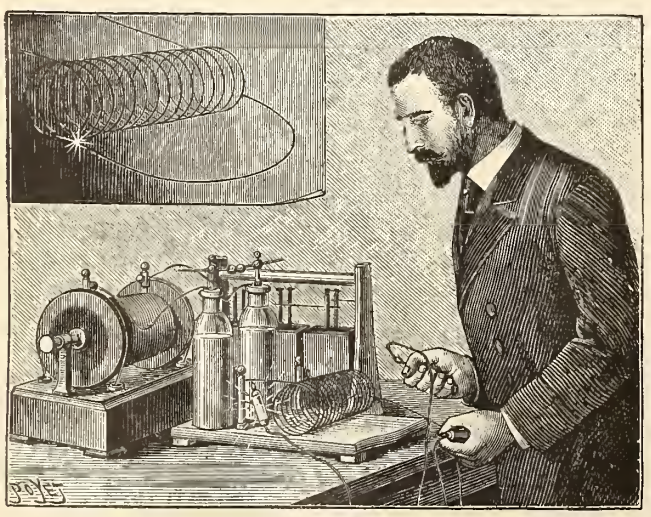


Fig. 2.—APPARATUS FOR THE ELEMENTARY STUDY OF THE PROPERTIES OF THE OSCILLATORY CURRENT.

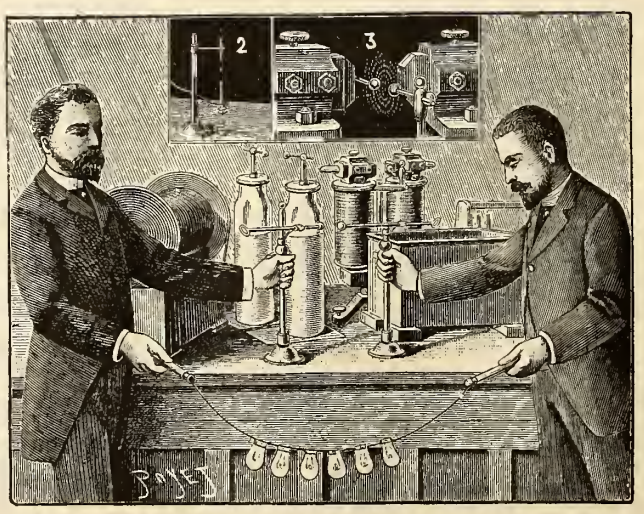



Fig. 3.—APPARATUS FOR THE PRODUCTION OF INTENSE OSCILLATORY CURRENTS.

conductors, we shall find that the skin has become insensible. This insensibility lasts from a few minutes to half an hour. 2. Under such conditions, and also upon insulating one's self upon a glass stool, and in taking but one pole, a sensation of heat is obtained soon accompanied with an abundant production of perspiration and with a considerable vascularization of the cutaneous surface. 3. Finally, if a small wound be made in the foot of an animal, so that the blood escapes from it drop by drop only, the hemorrhage will be seen to become very abundant under the influence of the current. There is then an energetic vaso-dilative action.

Therefore the current traverses the body, but the nerves have become insensible to such a frequency.

The few experiments we have just described may be made with the small apparatus that we spoke of in the beginning; but a more powerful installation permits of greatly increasing the effects, without, moreover, essentially modifying them. Fig. 3 shows the large apparatus, in which a transformer supplied by an alternating current dynamo is substituted for the bobbin. The discharge spark of the Leyden jars, instead of flashing forth in the free air, is produced in a powerful magnetic field. It then spreads out in a luminous circle and produces a deafening noise. We no longer light again as shown in the figure, a single lamp, but an entire series of lamps that the operators hold in the hand without a metallic communication with the apparatus.

It was in making allusion to this experiment that Mr. Cornu, at the session of the Academy of July 3, 1893, said: "It would be impossible to suspect the enormous quantity of electricity traversing our body; . . . transmitted under the form of alternating currents of long periods (from 100 to 10,000 per second), it would suffice to strike us down like a thunderbolt. Under the above conditions, it produces no appreciable sensation."

*Autoconduction.*—In all the experiments of which we have spoken, the oscillatory current engendered in a metallic circuit, was utilized either for its physiological effects or for its physical actions; but, as we have seen, this current possesses an enormous inductive power. Why, then, would it not produce induction directly in the living tissues? Every part of the body, or such a part as it is desired to treat, would thus become the seat of an electro-motive force and be so entirely, or one region only of the body would be uniformly penetrated by the currents that originate in the very midst of the tissues. This is what Mr. D'Arsonval demonstrates by means of the following experiments:

In Fig. 4 we see an operator carrying a brilliantly lighted lamp upon his forehead. This lamp, mounted upon a single turn of wire, is a few centimeters distant from a crown, with which it has no direct communication. This latter, traversed by the oscillatory discharge, develops in the ring a current sufficient to supply the lamp. Consequently, it is clear that the head itself is traversed by analogous currents.

The existence in the human body of currents produced by autoconduction may be rendered evident by a conclusive experiment. If the operator surrounds a solenoid (as shown in Fig. 5) with his arms, thus forming a circle completed by a lamp, whose terminals he holds in his hands, the lamp will be observed to become illuminated. An analogous phenomenon occurs when the patient is inclosed in a solenoid (Fig. 6).

The measurement of currents of great frequency naturally necessitates new processes. The one to which a chance experiment led Dr. D'Arsonval is not yet perfect, but it permits, at least, of registering the currents employed and of reproducing them at will. The currents induced in the interior of the conductors disengage heat, which is the measure of their energy. It will suffice, then, to cause the induction to act upon a mercurial thermometer and to note the elevation of its temperature in order to obtain an idea of the intensity of the inductive current, if its frequency varies but slightly.

At the top of Fig. 3 (No. 2) will be seen the arrangement of the experiment. The thermometer is placed in the axis of a small solenoid traversed by the oscillatory discharge. In an instant, it will be seen to rise by 150 or 200 degrees.

Currents of high frequency now give us so singular results that no one would have predicted them four or five years ago. Some engineers think that their industrial future is immense, and it would be very imprudent to assert the contrary. Their physiological actions are mysterious, and although Dr. D'Arsonval has had the merit of discovering some of them, it must not be forgotten that in this domain, which was untrodden but a few months ago, almost everything remains to be done. The methods have been devised, and it merely remains to set one's self to work.—*La Nature.*

## THE LIGHTING OF FIFTH AVENUE, NEW YORK.

ABOUT a year and a half ago the low tension system of street lighting was introduced for the first time in New York on Fifth Avenue. It had been found that some such device must be resorted to, for series arc lamps were little demanded on that avenue for commercial purposes, and the expense of laying the wires for conduits for street lighting alone was so great as to be practically prohibitive. Accordingly the Edison Illuminating Company solved the difficulty very satisfactorily by employing a low tension system, in which a pair of arc lamps on each post were used instead of a single lamp with dead resistance, as had been the case in previous attempts at low tension arc lighting. Each of these lamps, which were of the Bergmann type, manufactured by the General Incandescent Arc Light Company, took five amperes at approximately 50 volts, so that practically the same amount of energy was used as in the high tension arc lamp on the series circuit. The low tension system also possessed a number of advantages over its older rival. In the first place, it was possible to connect the lamps directly to the Edison low tension mains, thus effecting a great economy and adding to the convenience and flexibility of the system; secondly, the light was more effective on account of better diffusion, as the casting of shadows was practically obviated.

An ornamental post was employed made in three parts, the base, the shaft and the arm section. Instead of placing the resistance in the hood of the lamp, it was located in the base, and the lamps were lowered and raised from within the shaft, to which access was had by means of a door in the base, the key of which was carried by the trimmer. The lamps are fed by a sliding contact, so that when they are lowered the current is entirely shut off and the trimmer is perfectly safe from even a low tension shock. The lamps are supplied from the mains by the ordinary house service method, wires running through the gas pipe which forms the center part of the shaft.

One of the great advantages of this system of lighting is the ornamental appearance of the posts and the lamps, which greatly surpass in this respect the older type of series lamp. This system has been found to operate most satisfactorily during the past eighteen months, and the only criticism passed upon it was that the avenue was not as brilliantly lighted as had been anticipated. The Edison Company recently decided to overcome this difficulty by doubling the number of lamps, and accordingly have inserted at the center of each block another post carrying two lamps. There are now 114 posts, which, with two lamps each, makes a total of 228 lamps. This has had the desired effect, and as may be seen from the illustration given herewith, Fifth Avenue is one of the most brilliantly illuminated thoroughfares in the city. At the same time the light is much more soft and pleasing than that which is given by high tension lamps.—*Electrical World.*

ELECTRIC LIGHTS, FIFTH AVENUE, NEW YORK.

## ELECTRIC SIGNALING WITHOUT WIRES.*

By W. H. PREECE, C.B., F.R.S.

WHAT is electricity? Few venture to reply boldly to this question, first, because they do not know; secondly, because they do not agree with their neighbors, even if they think they know; thirdly, because their neighbors do not agree among themselves, even as to what to apply the term. The physicist applies it to one thing, the engineer to another. The former regards his electricity as a form of ether, the latter as a form of energy. I cannot grasp the concept of the physicist, but electricity as a form of energy is to me a concrete fact. The electricity of the engineer is something that is generated and supplied, transformed and utilized, economized and wasted, meted out and paid for. It produces motion of matter, heat, light, chemical decomposition, and sound; while these effects are reversible, sound, chemical decomposition, light, heat, and motion reproduce those effects which are called electricity.

Faraday's immortal researches, Clerk-Maxwell's prophetic investigations, and Hertz's convincing experiments, have definitely and conclusively proved the existence of one medium throughout all space, called the ether, through which waves of energy, called radiations, are propagated with the same velocity, but in different forms and with different frequencies, although all of the same character. At one end of the scale we have actinic disturbances producing photographic impressions; at the other end of the scale electric waves producing electromagnetic disturbances, while the immediate radiations give light and heat. Actinic waves are extremely minute and number many millions per second, electric waves are very long and may number only hundreds per second. Like light waves, they are propagated in straight lines, they obey the laws of reflection, they are refracted, they are subject to interference, and they may be even polarized.

We have to consider electric waves to-night, and I want to show you how we are gradually, by patient plodding, creeping along toward the period when I hope we shall be able to make real, practical use of such electromagnetic disturbances.

If we take a conductor through which a rapidly alternating current is being supported by any means, it throws the ether which surrounds it into oscillations. Energy is thus radiated away in electric waves. These electric waves spread out in all directions, as do waves of light, and if they fall on similar conductors properly placed and sympathetically prepared, these waves of energy are transformed back again into alternating currents which give evidence of their presence. Their presence *is* indicated by a telephone if the frequency of the alternating currents is brought within the range of the ear. Hertz and his followers experimented with waves of much shorter length, and with sparks in air, but all my experiments have been made with telephones and with waves comparable in frequency with those of sound.

The prime source of energy has been either a steam engine or a galvanic battery. This has produced, by suitable machinery, rapidly intermittent or alternating currents which have been transmitted through a primary circuit. At some distance away from this circuit there has been a secondary telephone circuit, and between these two circuits the only connecting medium has been the ether, which has been thrown into electric oscillation, and it has been across this space that I have been signaling without wires. In all cases, the primary currents were of such a frequency as to produce a musical note in the telephones fixed in the secondary circuit, which could easily be read if sent in the dots and dashes of the Morse code.

Signaling through space is very fascinating. I have now for ten years been steadily investigating the subject. In 1884, messages sent through insulated wires, buried in iron pipes in the streets of London, were read upon telephone circuits erected on poles 80 feet away on the housetops. It was imagined this must have been due to accidental connections, or to earths, or to any other cause but the true one, namely, electromagnetic induction, or the influence which one conductor conveying currents exercises on another parallel to it, when separated by a dielectric, or by mere space, that is, by the ether.

It is very difficult to convert the human mind from one mode of thought to another. We have been so trained to regard currents of electricity as something

* A paper recently read before the Society of Arts, London. From the *Journal* of the Society.

flowing in one complete unbroken circuit, that their temporary condition as waves of energy in space is difficult to realize. One irresistibly endeavors to trace them to earth conduction, to leakage, to contact, or to some more well known cause. Ten years of unremitting experiment have, however, proved the effects I am bringing before you to be due, primarily, to radiation, and not to conduction.

In 1885, a very exhaustive series of experiments was made for me by Mr. A. W. Heaviside, in the neighborhood of Newcastle, to find out how far the distance between the wires affected the results. Ordinary telegraph working currents produced disturbances at a distance of 2,000 feet, while effects on parallel lines of telegraph, 10¼ miles apart, between Durham and Darlington, were perceptible. Distinct speech was carried on through a distance of one quarter of a mile. We even obtained indications of current between the east and west coasts, 40 miles apart, but these observations were vitiated by conduction through the large network of telegraph wires between those two places. I brought the subject before the British Association at their meeting in Birmingham in 1886. The district between Gloucester and Bristol, along the banks of the River Severn, was then selected, where for a length of 14 miles, and at an average distance apart of 4·5 miles, no intermediate disturbing conductors existed. I was able to experiment with complete metallic circuits, the return wires passing far inland, in the one case through Monmouth, and in the other through Stroud. Weak disturbances were detected. These experiments were repeated. with more experience and greater success, in 1889. Similar experiments were conducted along the valley of the Mersey. A new trunk line of copper wires that was being erected between London and the coast of North Wales was then experimented upon, and some interesting results were obtained in the district between Shrewsbury and Much Wenlock, and between Worcester and Bewdley.

An admirable series of experiments were made for me in the same year, by Mr. Gavey, near Porthcawl, in South Wales. There we have a wide expanse of sand well covered by the tide and giving the opportunity to observe the effects in water as well as in air. Squares of insulated wire, 1,200 yards long, were laid side by side at various distances apart, and smaller squares were suspended above each other on scaffold poles. The effects were observable equally in air and water. The results were absolutely conclusive that we were working with the so-called electromagnetic induction, and all subsequent experience has confirmed this conclusion.

These further experiments were brought before the British Association at Manchester in 1887.

Thus the theory of the thing had been thoroughly thrashed out, and it only waited for some convenient opportunity to give it a practical test.

When the Royal Commission to inquire into electric communication between the shore and lighthouses and light vessels was appointed in June, 1892, the question was started. Here was the opportunity. My proposal to test this means of communication in a practical way was submitted by the postmaster-general to the treasury. The expenditure was sanctioned, and the experiment made. The results were submitted by me to the Electric Congress which was held in Chicago in August in 1893.

The Bristol Channel proved a very convenient locality to test the practicability of communicating across a distance of three and five miles. Two islands. the Flat Holm and the Steep Holm, lie off Penarth and Lavernock Point, near Cardiff, the former having a lighthouse upon it. On the shore two copper wires weighing 400 pounds per mile, forming one conductor, were suspended on poles for a distance of 1,267 yards, the circuit being completed by the earth. Experience justified the assumption that the earth acts as a conductor, and that it practically replaces the fourth side of the rectangle used in the previous experiments. We have not yet determined the actual position of the resultant line of this earth side, but further experiments are being made. On the sands at low water mark, 600 yards from this primary circuit and parallel to it, two ordinary gutta percha covered copper wires and one bare copper wire were laid down, their ends being buried deep in the ground by means of bars driven in the sand.

One of the gutta percha wires was lashed to an iron wire to represent a cable. These wires were periodically covered by the tide which rises here at springs to 33 feet. On the Flat Holm, 3·1 miles away, another gutta percha covered copper wire was laid for a length of 600 yards.

There was also a small steam launch having on board several lengths of gutta percha covered wire. One end of such a cable, half a mile long, was attached to a small buoy, which acted as a kind of float to the end, keeping the wire suspended upon or near the surface of the water while the launch slowly steamed ahead against the tide. It was paid out and picked up in several positions between the primary circuit and the islands.

The apparatus used on shore was a two horse power portable Marshall's steam engine, working a Pike & Harris' alternator, sending 192 complete alternations per second at a voltage of 150, and of any desirable strength up to a maximum of 15 amperes. These alternating currents were broken up into Morse signals by a suitable key and sent along the primary circuit. The signals received on the secondary circuit produced sound and were read on a pair of telephones—the same instruments being used for all the experiments.

The object of the experiments was not only to test the practicability of signaling between the shore and the lighthouse, but to differentiate the effects due to earth conduction from those due to electromagnetic induction, and to determine the effects in water.

It was possible to trace, without any difficulty, the region where the signals ceased to be perceptible from currents, due to earth conduction, and where they commenced to be solely due to electric waves. This was found by allowing the paid out cable, suspended near the surface of the water, to sink. Near the shore, no difference was perceptible, whether the cable was near the surface or lying on the bottom, but a point was reached where all sounds ceased as the cable sank, but were recovered again when the cable came to the surface.

The total absence of sound in the submerged cable rather surprised me, and it leads to the conclusion, either that the waves of energy are dissipated in the sea water or else that they are reflected away from the surface of the water like rays of light. I believe implicitly in the latter explanation. Subsequently, experiments on the sands in the Conway Estuary showing the relative transparency of air and water to these electric waves tend to support the latter deduction; for, if waste of energy took place in the water, the difference would be more marked than was actually found to be the case. It was 6 per cent. only. As it is, we have ample evidence that the electric waves are transmitted to considerable distances through water, though how far remains to be found out.

There was no difficulty in communicating between the shore and Flat Holm. Messages were read. Mr. Gavey, who was making the experiment on the island, wrote me: "There was then a somewhat lengthened pause, due to a slight derangement of the machinery on the mainland, but at 2 P. M. I heard clearly and distinctly the following: 'Here Haskayne' (one of his assistants) 'with a message from Mr. Preece for Mr. Gavey.'" I was in London that day. "Then followed the announcement of the sad and sudden death of Mr. Graves, which cast a gloom over the success of the experiment. It seemed an extraordinary fact that the first readable message transmitted for such a distance by such means should announce the death of the head of the technical department."

The distance between the two places was 3·1 miles. The attempt to speak between Lavernock and Steep Holm was not so successful. The distance was 5·35 miles, but though signals were perceptible, conversation was impossible. There was distinct evidence of sound, but it was impossible to differentiate the sounds into Morse signals. We were just on the limit of audibility, and we were using our available maximum power. If either line had been longer, or the primary currents stronger, we should have spoken as was done at Flat Holm.

As the laws governing these effects were by no means so clear and conclusive as such probing and inquiring deserved, Mr. Gavey and Mr. Kempe conducted for me a very careful series of experiments near Frodsham, on the estuary of the Dee, which was found to be a more convenient locality than Conway, and the very satisfactory results obtained will shortly be published. The conditions are now so clear that, given the localities between which it is desired to communicate, it is a mere matter of calculation to show what has to be done. It would be quite easy to speak between France and England across the Straits of Dover.

There happens to be a very convenient and accessible loch in the highlands—Loch Ness—forming part of the route of the Caledonian Canal between Inverness and Bannavie, having a line of telegraph on each side of it. Five miles on each side of this loch were taken and so arranged that any fractional length of telegraph wire on either side could be taken for trial. Ordinary and not special apparatus was employed, sending messages, as before, by Morse signals, and speaking by telephone across a space of one and a quarter miles was found practical, and, in fact, easy; indeed, the sounds were so loud that they were found sufficient to form a call for attention.

The following apparatus was in use on each side of the loch for the transmission of Morse signals. A set of batteries consisting of 100 dry cells, giving a maximum voltage of 140; a rapidly revolving rheotome which broke up the current into a musical note; a Morse key, by which these musical notes could be transformed into Morse signals; resistance coils and ampere meters to vary the primary current; two Bell telephones joined in multiple are to act as receivers. For the transmission of actual speech simple granular carbon microphones, known as the Deckert's, were used as transmitters, and a current of two amperes was maintained through these and two Bell telephones in circuit with the line wire.

Any lingering fear that earth conduction had principally to do with these results was removed by making the earth's terminals on the primary circuit at one end at Inverness nine miles away and at the other end in two directions in a parallel glen about six miles away. The early experiments of 1886, in the valley of the Severn, had placed this question of earth interference beyond the region of doubt, but earth conduction, as a main factor in the results, is still believed in by critics. The function performed by the earth has been thoroughly developed in the Frodsham experiments, and will be discussed subsequently.

One very interesting fact observed at Loch Ness was that there was one particular frequency in the primary circuit that gave a decided maximum effect upon the telephones in the secondary circuit. This proves the presence of resonance, and is, of itself, a fact sufficient alone to prove the effects as being due to the transformation of electric waves into electric currents.

It is well known that every telephone has one particular note—the natural note of the disk—to which it responds better than to any other, but this resonant effect far exceeded in magnitude any difference due to the natural pitch of the disk. It was not the natural note.

Conversation by telephone, though possible, was not however practical. Still, it is something to have transmitted speech by electricity across an air space of 1¼ miles. We had this curious condition, that at some intermediate point the energy of the human voice was found side by side in two different forms—sonorous vibrations in the air and electric waves in the ether.

There is now no difficulty in communicating with outlying islands if the conditions are favorable. The Northern Commissioners of Lights are anxious to establish electrical communication with the Muckle Flugga lighthouse, at the extreme north of the Shetland Islands, but the place is so inaccessible that, though the conditions are favorable and signaling without wires is possible and simple, it would be more prudent to adopt the more expensive plan of a submerged cable. I would rather inaugurate the system nearer home, where it could be watched, nursed, and improved. Anyhow, it is something to be able to report that we have now acquired a practical system of signaling across space without the necessity of using wires.

Although this short paper is confined to a description of a simple practical system of communicating across terrestrial space, one cannot help speculating as to what may occur through planetary space. Strange, mysterious sounds are heard on all long telephone lines when the earth is used as a return, especially in the calm stillness of night. Earth currents are found in telegraph circuits, and the aurora borealis lights up our northern sky when the sun's photosphere is disturbed by spots. The sun's surface must, at such times, be violently disturbed by electrical storms, and if oscillations are set up and radiated through space, in sympathy with those required to affect telephones, it is not a wild dream to say that we may hear on this earth a thunderstorm in the sun.

If any of the planets be populated with beings like ourselves, having the gift of language and the knowledge to adapt the great forces of nature to their wants, then if they could oscillate immense stores of electrical energy to and fro in telegraphic order, it would be possible for us to hold commune by telephone with the people of Mars.

## ORIGIN OF PETROLEUM.*

Petroleum has been known from a very ancient date. Italy, Persia, India, the borders of the Caspian Sea, Java, and North America possess petroleum springs, discovered ages ago. About 1859 the existence of large petroleum reservoirs was signalized in Pennsylvania. Contrarily to what occurs in the case of many mineral substances like coal, which are limited to certain well marked strata, the layers which furnish mineral oil belong to several very different strata of stratified earth.

Although petroleum has been studied in many countries, its origin has not yet been determined with certainty. The theories expressed on this subject may be divided into three groups, according as the origin of the petroleum is mineral, vegetable, or animal.

We shall pass in review the most important theories, concluding each by an account of the criticism directed against such theory.

(1) *Mineral Origin.*—Mendeleeff asserts that petroleum results from the action of water on the carbureted metals inside the earth. We know, in fact, that ferromanganese with a large proportion of carbon can give, when treated with acids, gases and liquids of odor and appearance somewhat similar to those of petroleum. In his original memoir, published at St. Petersburg in 1877, Mendeleeff compares the interior of the earth, especially at the extremity of the terrestrial crust, to a blast furnace at work, and demonstrates in this manner that in both cases there is a zone of carbureted metals, especially pig iron, and above a zone of scoriæ. This last supplies the material of volcanic eruptions, and causes the formation of basalts, trachytes, porphyry, etc.

In consequence of the upheavals, crevices and fissures are formed inside the earth, through which the water penetrates to the fused carbureted metals, reacts upon them and gives birth to hydro-carburets. Geologists were the first to criticise this theory. To commence the reaction immediate contact is indispensable; but this is impossible if we refer to the hypothesis of Mendeleeff. We distinguished from bottom to top a zone of carbureted iron in fusion, and above the scoria and solid mass which constitutes the terrestrial crust. The formation of fissures cannot take place unless the substance is solid and brittle—their presence is unimaginable in plastic or liquid substances. Consequently, fused metals are protected against the irruption of waters by the zone of liquid scoriæ, and mutual action cannot exist.

To overthrow this theory—called "Theory of Emanations"—as also the hypothesis of a high temperature, it suffices to observe that the place of formation of petroleum is distant from the pyrosphere. Petroleum only appears accidentally, entirely in small quantities in the eruptive masses; that found in slimy volcanoes and the fumes is, as has been demonstrated, of organic origin. Archaic rocks—which, according to the preceding theory, should be richer in petroleum because they are purely and simply the first recipients of the petroleum coming from the interior of the earth—hardly contain any at all. Besides, after exhaustion of the actual strata, new supplies of mineral oil would ascend from the depths of the earth by virtue of the pressure, and should be of a temperature greater than that of the ground in their vicinity; but such is not the case.

In 1866, Berthelot expressed the opinion that inside the earth aldehydrates are formed at the expense of carbonic acid and alkaline metals, which on contact with the water steam produce acetylene, and this last, under the influence of the temperature and pressure, give rise by condensation to the petroleum and pitchy substances accompanying.

Ten years later Bryasson demonstrated that a mixture of water vapor, carbonic acid and sulphureted hydrogen can produce petroleum.

(2) *Vegetable Origin.*—The hypothesis of the vegetable origin of petroleum has still many partisans, who assert that petroleum is produced by the decomposition of marine plants, chiefly fucoids. They thus explain the presence of salt water and rock salt; consequently, its origin is given as analogous with that of coal, peat, etc.

Mendeleeff objects, with reason, to this theory, that if the petroleums were of organic orgin, we should find vegetable remains in the strata. Now, nothing of the kind has been remarked, and it is difficult to admit that organic substances can have been transformed into oil without leaving a carbonaceous residuum. One cannot, either, admit the supposition that the carbon may have disappeared under some influences to which the oil resisted. Besides, the products of decomposition of a vegetable nature always contain benzine, and this last exists with its higher homologues in the products from distillation of cannel coal, together with carburets identical with those of the petroleum described by Schorlemmer. In America, the Silurian strata, which are very rich in petroleum, are found to contain a few layers of coal, but they are of too little consequence to admit of a relation between their presence and that of petroleum. Likewise, in Pennsylvania, coal is found with petroleum, but the first is in upper strata, whereas the petroleum contained in the Devonian strata is below the coal, and separated from

* From *Le Mercure Scientifique*; *Light, Heat and Power.*

it by layers of humid clay impermeable to petroleum. This hypothesis cannot be accepted with certitude.

(3) *Animal Origin.*—The hypothesis of aniual origin of petroleum is the most recent. In the first place, it was asserted almost everywhere that petroleum originates in vegetable substances, because no cause could be assigned for the collection, in so limited a space, of such large quantities of marine animals. But to day this latter hypothesis is maintained by most chemists. It is for these reasons that we shall examine with more detail each of the opinions expressed regarding the animal origin of petroleum.

First, let us mention the researches of Engler ("D. Chem. Ges.," 1888, p. 1816; "Chem. Z. T." 12, p. 842), which serve as basis of the chief theories about to be examined. Engler distilled 9 hundredweight, 2 quarters, 20·674 pounds of fish oil between 320° and 400°, under a pressure which was 10 atmospheres at the beginning of the operation and then fell to 4 atmospheres. Combustible gases were passed—an oily liquid and water. By fractional distillation of this oil, Engler isolated pentane, hexane, heptane, ortane, nonane, and carburets of other classes. He obtained a raw oil of 60 per cent. of the weight of the fatty substances employed, and nine-tenths of this oil was composed of hydrocarburets. In addition it possessed nearly all the properties of natural petroleum. The gases escaping, although their composition was different from that of gases which accompany mineral oil, contained principally methane. Later, Engler distilled some thousands of mollusks and sea fish at Hamburg; he collected quantities of ammonia and nitrogenous organic bases

According to Zaloziecki, the researches of Engler are not conclusive—do not demonstrate with certainty the animal origin of petroleum—for two reasons:

(1) Its distillation dry demands a high temperature, and this condition should be eliminated in the formation of petroleum.

(2) The products distilled under pressure have only a slight analogy with the elements of natural petroleums, these products distilled not containing aromatic carburets, and especially carburets of the naphthene class, which compose the second essential portion of petroleums, and are found in all.

After having exposed the works of Engler, we come to the theory of Hofer, who, fourteen years ago, stated that the origin of petroleum was animal, and maintained his opinion with obstinacy.

The only serious objection made for a long time to the new theory was the absence of nitrogen in petroleum, for they said that the existence of nitrogen or of its combination should be demonstrated in petroleum if produced by animal decomposition.

Even geologists supported the chemists against the opinion of animal origin. Peckham, having found nitrogen in the petroleums of California, Texas, West Virginia, and Ohio, recognized the exactness of the new theory; but as he did not find this element in the petroleums of Pennsylvania (New York), he concluded that these should, on the contrary, have a vegetable origin, and with him American geologists admitted that, according to its composition, petroleum was of vegetable or animal origin. According to Hofer, however, the geological conditions of the State of New York (Pennsylvania) do not agree satisfactorily with the vegetable origin.

To appreciate the importance of the presence of nitrogen in petroleums, we must follow the different transformations of the animal substance. In decomposition of this last gases are formed, and consequently one may ask whether the nitrogen has not disappeared in the gases accompanying the petroleums. Now, the analysis of fossil gases from Pennsylvania showed the presence of 27·87 per cent. of nitrogen, which, as Hofer demonstrated, cannot originate in the air, the oxygen of which would have disappeared in oxidizement of the carbon, giving rise to $CO_1CO_2$. These analyses have a great scientific importance; they prove that there is no relation between nitrogen and oxygen existing under the form of $CO_1CO_2$ in fossil gases, and they make Hofer conclude that these two oxides, far from originating in the oxygen of the air, are, like nitrogen, products of decomposition of animal substances. According to Engler, the proportion of nitrogen in fossil gas of Pechelbrom (Alsace) fluctuates between 8, 9, and 17·2 per cent.; if the proportion of oxygen is found, free or combined, and then the amount of nitrogen requisite to form air, this quantity is most frequently observed to be too small, so that even in the most unfavorable hypothesis there remains an excess of frec nitrogen.

In the following table are classed the analyses made by Hofer with gases accompanying petroleum. The proportion of oxygen, free or combined, is indicated in the last column but one, and the last includes the quantities of nitrogen requisite for this oxygen to form air. These quantities of nitrogen, in five analyses, were found smaller than those which compose fossil gases; consequently, the presence of this free nitrogen is due purely and simply to the decomposition of substances of animal origin.

In Table II. we find no proportion between the amount of nitrogen and that of $CO_2$; that is to say, of oxygen. Thus the smallest amount of $CO_2$ (Analysis 2) corresponds with the highest quanity in nitrogen. As for the Torrente Sillaro gas, it should be analyzed again, on account of the large proportion of iodide of ethyl as yet found nowhere.

Nitrogen exists in all fossil gases, whether these last are contained in the limestone of Ohio, Indiana, or in the conglomerates and sandstones of New York, Pennsylvania, or again, in the schistons, clays, sands and clays properly so called (Apscheron Baku, Italy); only the composition of fossil gases, collected in the holes bored, frequently changes in the space of a few days to a remarkable extent.

The presence of nitrogen in petroleums is not requisite even in the hypothesis of animal origin. The absence of this element can, according to Engler, be explained as follows: We know that animals are formed in the soft parts by a nitrogenized fleshy portion and another composed of fatty substances free from nitrogen. At the time of putrefaction of the carcasses the nitrogenous part is rapidly decomposed, while the fatty substance is distinguished by a very special stability. In support of this he mentions the existence of adipocire, or grave wax, in every grave, and the presence of fatty substances in fossils, especially in the fossil bones of the bison of America. Engler says, also, that Gumbel found, at a depth of 546.816 yards, and even more, globules of fatty substance accumulating more or less in the slime, owing to the death of animalcules, and that this chemist concludes that petroleum should often be found in nummulitic soils. Considering the ready decomposition of nitrogenous fatty substances, and the firmness of substances free from nitrogen, the decomposition of the first has made great progress, and perhaps is already concluded when that of the second commences. The gaseous products from decomposition evidently containing nitrogen have consequently been able to accumulate in some part of the porous rocks before decomposition of the non-nitrogenized substances; that is to say, the very formation of petroleum was prepared.

During later times several geologists of America—among others M. Orton—only ascribed an animal origin to petroleum in contact with limestone, but not to that mixed with sandstone and schist. To support this new hypothesis, he states that Mr. Kemp discovered that the fossil gas produced in limestone contained, like the petroleum, sulphureted hydrogen, but that this gas was wholly absent in soils containing silicates. But Mr. Hofer demonstrated that sulphureted hydrogen often originates in the decomposition of sulphates held in water, fossil gases being powerful agents of reduction hitherto not appreciated at their full value, and which hold in mines a commanding position in the formation of metallic sulphurets. Again, petroleum springs have been found in Italy with water containing sulphureted hydrogen, although the petroleum was not in contact with limestone, but with silicates. In short, both Engler and Hofer admit for petroleum and ozokerite, or fossil wax, an animal origin. The study of the first layers of petroleum discovered, and the transformation, through heat and pressure, of the fatty substances into a petroleum-like product, without any formation of carbonaceous residuum or appreciable loss of gas, are in favor of their claims.

The first part of the problem, then, according to these chemists, is solved. But they neglect or omit the causes of the transformation and the manner in which it has occurred. This leaves the second and more important part of the problem—as to how the petroleum was found—still unsolved. The works remaining to be examined, especially those of Zaloziecki and Schsenius, have as their principal object the discovery of the solution to this part of the problem.

Let us summarize the theory of Zaloziecki. He supposes a slowly progressive decomposition of the carcasses accumulated in maritime districts under the strong agency of sea currents. There are two phases in this decomposition—putrid fermentation and bitumenization, with change of exterior conditions, stratification and the inaccessibility of air. By bitumenization we mean a gradual destruction of the fatty acid molecules under the actions of high temperature, pressure and time, this decomposition occurring with formation of carbonic acid and carburets, saturated and non-saturated. These last, subjected to secondary influences, were condensed and polymerized, producing aromatic carburets and hydrozets of these. In the analogies employed by Zaloziecki, petroleum and fossil wax are products from the decomposition of animal substances, just as coals are the remains of vegetable substances, and the various degrees of bitumenization, adipocire, ozokerite, and petroleum are set parallel with the various states of decomposition of vegetables, peat, lignite, anthracite, etc.

In studying the agencies which tend to produce the formation of petroleums, Zalozicki shows how experience has proved that bitumen is especially abundant in sedimentary rocks; and hence its formation from animal substances is probable, as the transformation of these has taken place under the action of interior influences very like those which formed the sedimentary rocks From this several conclusions may be drawn, the most important being that the sedimentary materials having been subjected in the course of time to changes which are still at work, the organic layers of the same epoch have necessarily undergone continual and progressive transformations. We may admit with near certainty that petroleum is absent from soils of recent formation, alluvial and diluvial, while it is found in tertiary soils. As there is no reason for denying the presence of the necessary materials for formation of petroleum at the alluvian period, we must consider time as a most potent and necessary factor.

| | $CH_4$ | N | H | $C_2H_4$ | O | $CO_2$ | CO | $H_2S$ | Total. | O Total. | N for Air. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Findlay, O | 93·35 | 3·41 | 1·64 | 0·35 | 0·39 | 0·25 | 0·41 | 0·20 | 100 | 0 80 | 2·66 |
| (2) Fostoria | 92·84 | 3·82 | 1·89 | 0.20 | 0·35 | .. | 0·55 | 0·15 | 100 | 0·81 | 2·70 |
| (3) St. Mary's | 93·85 | 2·98 | 1·74 | 0·20 | 0·35 | . | 0·44 | 0·21 | 100 | 0·77 | 2·56 |
| (4) Muncie, Ind | 92·67 | 3·53 | 2·35 | 0·25 | 0·35 | .. | 0·45 | 0·15 | 100 | 0·79 | 2·62 |
| (5) Anderson | 93 07 | 3·02 | 1·86 | 0·49 | 0·42 | .. | 0·73 | 0·15 | 100 | 0 02 | 3·34 |
| (6) Kokomo | 94·16 | 2·80 | 1·42 | 0·30 | 0·30 | .. | 0 55 | 0·18 | 100 | 1·82 | 2·73 |
| (7) Marion | 93·58 | 3·42 | 1·20 | 0·15 | 0·55 | .. | 0·60 | 0·20 | 100 | 1·11 | 3·69 |

Petroleum has also been found in Italy, in the province of Emilia. The terreous gases emitted by the muddy volcanoes were examined, and analysis gives the following results:

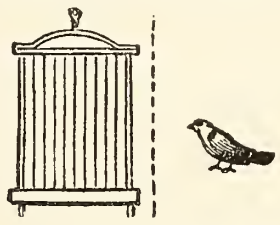
TABLE II.—FOSSIL GASES OF ITALY.

| No. Provinces. | | | $CH_4$ | N | $CO_2$ | $C_2H_5I$ | Analyses made by |
|---|---|---|---|---|---|---|---|
| 1, Bologna | Monte Sasso Cardo | | 91·82 | 3·13 | 2·05 | .. | Fouque & Gorceix. |
| 1, " | Fosso dei Bagni | | 91·35 | 8·04 | 0·61 | .. | " |
| 1, " | Sorgente dei Bovi | | 92·22 | 2·06 | 5·72 | .. | " |
| 1, " | Sorgente di Marte | | 92·16 | 2·78 | 5·06 | .. | " |
| 1, " | Sorgente del Leone | | 89·42 | 4·61 | 5·97 | .. | " |
| 1, " | Poretta Vecchia | | 90·75 | 7·23 | 2·02 | .. | (?) |
| 1, " | Sorgente di Puzzola | | 91·48 | 6·68 | 1·84 | .. | (?) |
| 1, " | Torrente Sillaro | | 80·60 | 0·39 | 1·14 | 17·87 | (?) |
| 2, Florence | Firenzuola Pietremala | | 96·19 | 2·27 | 1·54 | .. | (?) |
| 2, " | " " | | 97·48 | 0·77 | 1·75 | .. | (?) |
| 2, " | " " | | 98·85 | 0·41 | 0·74 | .. | (?) |
| 3, Bologna | Bergullo | | 98·83 | 0·59 | 0·48 | .. | (?) |
| 4, Ravenna | Rio de Bagni, Riolo | | 97·35 | 1·04 | 1·01 | .. | (?) |

(Poretta.)

## AN OPTICAL ILLUSION.

PLACE one edge of a visiting card along the line between the bird and the cage, and rest the tip of your



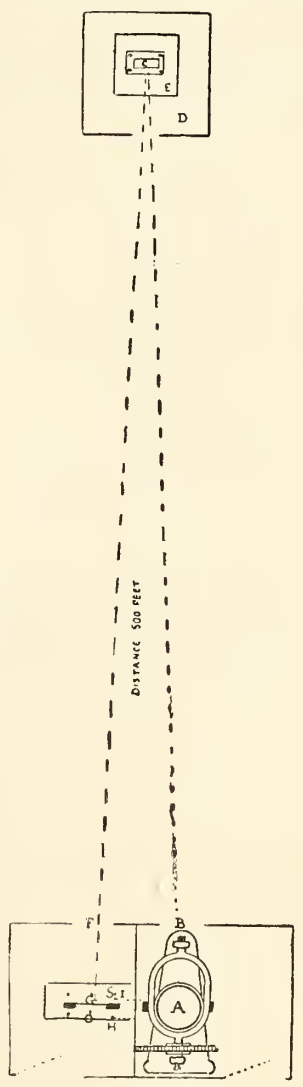
nose against the other edge of the card. Hold the card so that no shadow falls on either side. Watch the bird a moment, and you will see it go into the cage.

## LONG FOCUS TELESCOPES.

By WILLIAM ROLLINS.

THE obstacle to the increase in size and number of large telescopes is the cost. How can this be reduced? As the chief expenses of a great equatorial are the mounting and the dome, with its necessary machinery, these must be given up. Several other types have been proposed, but when telescopes having focal lengths of several hundred feet are used, only tne horizontal will be practical. At present this is but little used, and before its introduction can become general some new form must be given to it to overcome the difficulty of controlling the revolving mirror when the observer is stationed at the other end of the telescope many feet away. To be sure, the rate of the driving mechanism can be controlled from any distance by electricity, but for setting the mirror the observer ought to sit beside it.

I propose to reflect the light from the revolving mir-




ror to a fixed mirror distant half the focal length of the objective, and to send it back again to the observer sitting in a chair beside the driving mechanism. In the cut, A is the revolving mirror; B, the objective; C, the fixed mirror and G the eyepiece or sensitive plate. If the focal length of the objective is one thousand feet, then the fixed mirror will be five hundred feet from the revolving mirror. If the reflecting form is chosen there will be no objective, and the fixed mirror will be parabolic and placed at its focal length from the eyepiece at G. This form of mounting will be cheap, only two wooden sheds being required—one for the fixed mirror, the other larger and divided by a partition into two rooms—one for the mirror with its

driving mechanism; the other, a dark room taking the place of a camera, inside which the observer will sit while looking at the image on the plate in front of him, thus doing away with a guiding telescope. Rods and wires placed at his side will enable him to control the revolving mirror, while a slide in the partition will admit of direct access to the driving mechanism. A telescope of this type, with a focal length of five hundred feet, ought to be of value in lunar photography, even if the aperture was not larger than twelve inches. The two most probable causes of failure will be the difficulty of building a driving mechanism perfect enough to project a steady image so far, and distortion of the image from flexion of the mirrors. I propose to overcome the last by making the mirrors much thicker than is usual.—*Astronomy and Astro Physics.*

## THE MUSIC OF BIRDS.

The idea of scoring, imitating or translating the song of birds is an old one, and the Phonurgie of Father Kirchner, published in 1673, gives the first attempt of this kind.

In a very interesting article on the nightingale recently communicated to this journal, the author, Miss Beleze, in speaking of the tentatives that have been made in this direction in regard to this bird, said with good reason that they have never given brilliant results. That is true, and the assertion might be extended to the majority of other birds.

However, be it merely as a matter of curiosity, we propose to present a few very recent attempts in musical notation concerning the song of some of the birds of our country.

Honor to whom honor is due, and, since it a question of song birds, it is impossible not to begin with the nightingale. Apropos of this, let us recall the fact that, as long ago as 1787, *Les Affiches de Senlis* published the following reproduction of the song of the nightingale, taken, as it stated, from an Italian journal:

SONG OF THE NIGHTINGALE.

Tiûu, tiûu, tiûu, tiûu
Lpé tiû zqua;
Quorror pipu
Tio, tio, tio, tio, tix;
Qutio, qutio, qutio, qutio,
Zquo, zquo, zquo, zquo,
Zi, zi, zi, zi, zi, zi, zi, zi,
Quorror, tiû zqua pipiqui.

The transcriber of this song adds: "If men could penetrate the meaning of these words, they would surely see that each of them was a different expression of the secret feelings of this tender bird, since the end of its passion is the end of its song."

The French journalist does not follow up these words with any personal opinion, yet he remarks that the result is very curious if "they are allowed to be read by a woman who has a sweet and harmonious voice that conforms to the Italian pronunciation, which is different from ours."

Let us recall the pretty but fanciful translation of a French nightingale's song into human language ventured by Dupont de Nemours:

SONG OF THE NIGHTINGALE WHILE BROODING.

Dors, dors, dors, dors, dors, ma douce amie,
Amie, amie,
Si belle et si chérie
Dors en aimant,
Dors en couvant,
Ma belle amie,
Ma belle amie,
Nos jolis enfants,
Nos jolis, jolis, jolis, jolis
Petits enfants.
(*A short silence.*)
Mon amie,
Ma belle amie,
A l'amour,
A l'amour ils doivent la vie,
A tes soins ils devront le jour.
Dors, dors, dors, dors, dors, ma douce amie,
Auprès de toi veille l'amour,
L'amour,
Auprès do toi veille l'amour.

Such, says the poet, is the ground and spirit of the song, which, according to the sensitiveness of soul of the singer, is subject to many variations, for it must not be thought that all individuals sing exactly the same couplets, any more than it must be thought that they perform precisely the same actions. They have the same sentiment and manifest it in a manner that is not without analogy, that is all.

Less fanciful, Guésneau de Montbéliard, in speaking of the nightingale, has, with as much poetry, set forth "the incomparable resources of its voice: piercing single breaths; quick and light beatings; outbursts of song in which clearness is equal to volubility; an interior and dull murmur, which is not appreciable to the ear, but well adapted for increasing the effect of the appreciable tones; precipitate roulades, brilliant and rapid, articulated with force and even with a harshness in good taste; plaintive accents trilled with softness; notes sustained without art, but brimful of soul; enchanting and thrilling sounds that seem to come from the heart and that make every heart palpitate, and produce in every one who is sensitive so agreeable an emotion and so touching a languor."

The skylark, the "messenger of the dawn," the national bird of the Gauls, is the songster of the harvest-time and the only bird that sings while on the wing.

In measure as it ascends skyward, almost vertically and with successive bounds, it strains its voice. Its song bursts forth in sweet and vibrating melodies, and it is still heard while the eye seeks it in vain in sun-lit space.

"No throat," says Toussenel, "can compete with that of the skylark in richness and variety of song, fullness and softness of *timbre*, steadfastness and range of sound, and flexibility and untiringness of the vocal cords. It sings for hours at a time without stopping for half a second, ascending vertically to a height of three thousand feet in tacking about in the regions of the clouds in order to reach a greater height, and without any of its notes being lost in this extensive journey."

Alongside of these songsters of merit, let us place a few other birds not so well endowed and whose discordant screaks, such as those of the sparrow, or whos monotonous notes, like those of the cuckoo, it is easier to score.

The sparrow makes its cry heard all day long, but it is especially in the morning, at sunrise, that it is most lavish of it, and it must be confessed that the sound is not particularly agreeable to those who are condemned to hear it.

The notes of the cuckoo are likewise limited. Who does not know those two monosyllables, *coo-coo*, which fill our woods during the first days of April, and which are so characteristic that in all countries they have served as a denomination for the bird.

Nor can the ringdove be scarcely regarded as a good musician. It is in spring, at the break of day, especially in fine weather, that this bird, perched upon the summit of a tree, makes its sonorous cooing heard.

The turtle dove, whose repeated cooings recall those of the ringdove, sings upon two plaintive, melodious notes, rendered *turtur* by Latin onomatopœia, and which harmonize very well with the melancholy of the cool and thick woods wherein it nests by preference. With the thrush we return to singing birds. Still, it is necessary to be specific, for of the four kinds common to our country, there is but one that is remarkable for its song, and from this fact is derived its name of song thrush.

It translates an exuberant gayety by couplets that are as agreeable as they are varied. Perched at the very summit of a tree, it pours forth, during the first fine days of spring, before the buds have hardly opened, its ample and harmonious notes from morning till night and for hours at a time. It sings also until the month of August, that is to say, until the time of grape gathering, after which it seems that its extreme fondness for the grape causes it to forget its qualities as a musician. As soon as the vineyards offer their ripe grapes it partakes of the latter until it "loses its head" over them, and, starting from this epoch, it no

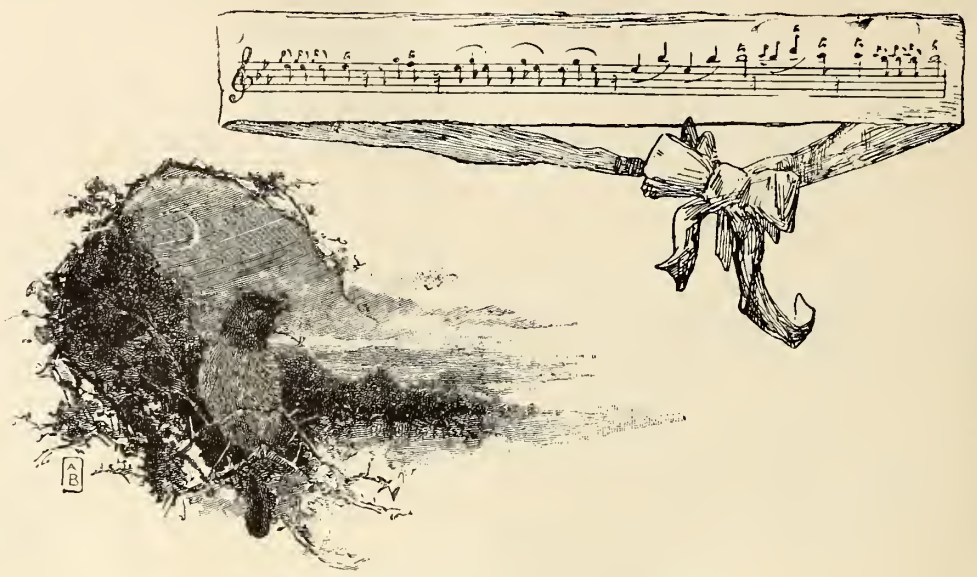


Fig. 1.—SONG OF THE NIGHTINGALE.

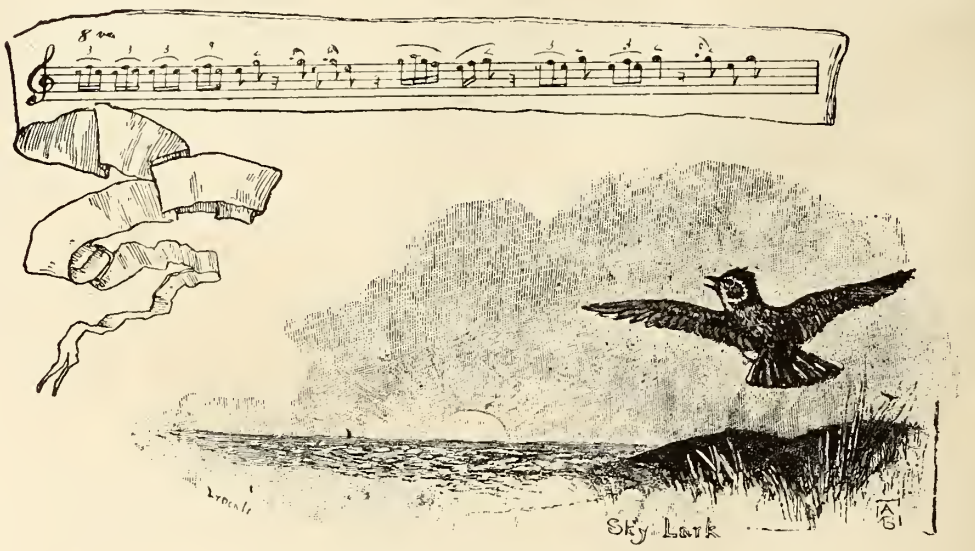



Fig 2.—SONG OF THE SKYLARK.

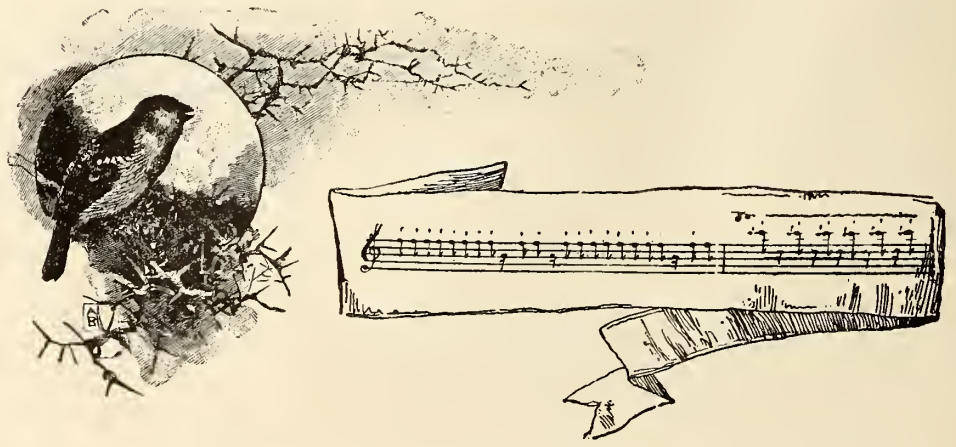


Fig. 3.—SONG OF THE SPARROW.

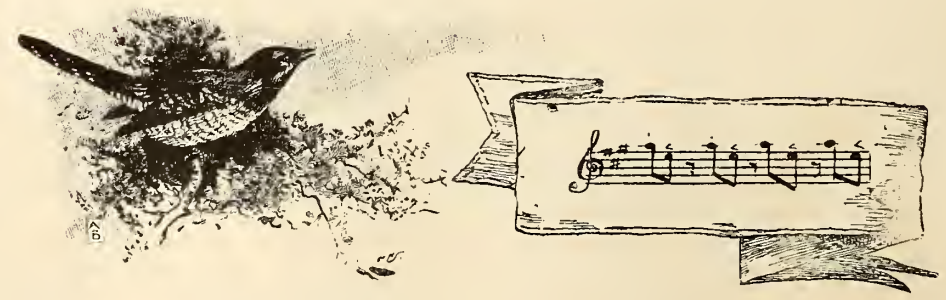


Fig. 4.—SONG OF THE CUCKOO.

longer utters any sound but a little hurried cry of *zip, zip*, which it allows to escape while flying away, affrighted by the shouts of the vine dressers.

The bullfinch, says Mr. V. Rendu, has great musical tendencies. It is not that its warbling is brilliant in a wild state, for, according to Guesneau de Montbéliard, its song consists of but three cries, which are not very agreeable. It begins with a whistle, followed by two more whistles, one after the other, and soon makes a greater number heard, the sound of which is pure. In measure as the bird becomes animated, its *tui, tui*, becomes more emphasized and terminates in a sort of warbling that amateurs have noted thus: *si, do, do, do, si, vé, do, do, do, do, do, do, si, vé, do.* It utters this in a graver and graver tone, almost stifled and degenerating into falsetto. In the pauses or intervals, it utters a little internal chirp, quick, abrupt, and very sharp, yet very low—so low indeed that it can scarcely be heard. The bill and throat seem to be strangers to this execution. The muscles of the abdomen are principally concerned in it; in other words, the bullfinch plays the ventriloquist.

By a peculiarity very strange in the feathered tribe, its song acquired artificially surpasses its natural song. In the hands of a skillful master, the bullfinch becomes really harmonious. When the bird organ allows it to hear, with method, mellower, finer and better sustained sounds, the bird, obedient to these lessons of taste, not only imitates them correctly, but sometimes gives a stamp of perfection to the airs that are whistled to it, without, for all that, renouncing its innate warble.

On the contrary, if it has to do with a bad musician, it repeats its lesson with deplorable accuracy. With it, memory plays an important role, and the gift of imitation seems to prevail over the musical taste, properly so called. What is something no less extraordinary, the female shares with the male the privilege of singing, and shows herself no less susceptible to this kind of training. She learns how to speak and whistle, and her voice, it is said, makes itself remarked by greater softness.

As regards "musical tendencies," there is perhaps a comparison to be made between the bullfinch and the canary bird. "If the nightingale is the songster of the woods," says Buffon, "the canary is the chamber musician. The former is master of entire nature, while the latter participates in our arts. With less strength and range of voice, and less variety in sounds, the canary has more ear, more facility of imitation, and more memory, and as it has a more attentive hearing, which is more susceptible of receiving and preserving external impressions, it becomes also more sociable, more gentle, and more familiar." It is this facility of imitation that it has in common with the bullfinch. In the portion of the song of the canary that we give herewith, one might find again some resemblance in method with the beginning of the song of the nightingale. The fact is that a canary is capable of imitating the song of any other kind of bird. It is capable also of imitating the sound of the ordinary flute, absolutely like the trained bullfinch, of repeating a few measures of a popular air, and even of learning how to pronounce a few words. It must be added, however, that such results cannot be obtained without difficulty.

In the beginning we quoted a fanciful translation that has been made of the song of the nightingale. With this interpretation may be compared that given of a few birds in certain districts by the peasants.

The quails arrive in our region toward the end of April and the beginning of May. Shortly after descending to the ground they begin to lay, and from this moment, in the grainfields and in the grass, etc., there are heard resounding the sonorous and abrupt notes of the female that have everywhere been translated by the cry of *paye tes dettes* (pay thy debts).

The chaffinch is not a singer, but we are thankful to it for being one of the first to open our spring concerts, and, moreover, although its musical phrase is not very harmonious or greatly varied, no bird can equal it in strength of lungs. It is this that has given the idea in certain countries, especially Flanders and Belgium, of getting up song contests between the male birds of this species. Scarcely has one of the rivals uttered his cry of defiance, when the other replies with a well emphasized trill. The combat, once begun, becomes a throat to throat duel, and it is to him who will extinguish the fire of his adversary by singing loud as long as possible. The contest thus lasts for hours. The last trill decides the victory, and such is the obstinacy of these musical combats that it is not rare to see the conqueror fall stone dead after a supreme effort to uphold the honor of its reputation.

During the winter the chaffinch, which remains with us, maintains silence, or merely utters a little oft-repeated *pick, pick.*

In Burgundy and the districts of eastern France the peasants have an amusing fashion of interpreting the song of this bird. As long as the inclement season lasts, and while the frozen earth is covered with snow and the chaffinch goes hopping about to repeat its plaintive cry before the door of dwellings, its utterance is considered as an appeal to every charitable heart, and the peasant translates it thus: *As-tu cuit? As-tu cuit?* (Hast thou cooked?)

But the chaffinch soon begins to "*Se moquer du laboureur,*" at least it is thus that its first strains are translated. Yet the bad days are still so near that the chaffinch seems to hesitate to proclaim the little value that it sets upon the services rendered, and to finish its irreverent phrase. This is not long delayed, however, and all the summer it keeps repeating: *Je me moque du laboureur? Je gagne bien ma vie sans lui.* (What do I care for the plowman? I make my living well without his aid.)

A finer musician is the goldfinch, so elegant in form, so brilliant in plumage and so petulant in gait. Each of its changes of place is accompanied with little joyful chirps, and, that no one may doubt its happiness to live, it sings from morning till night, at all hours of the day, with untiring animation.

When it is stationary, its preludes resemble a musical challenge that it is addressing to itself. It begins with simple notes, as if it did not dare at first to let itself out. As soon as it has begun, it gradually assumes boldness, elongates its phrases and balances them with the same motion that sways its body alternately to and fro, briskly sends back to itself a reply, and finally overflows with lyric enthusiasm. Its volubility then partakes of delirium. Again and again it sends forth its rapid notes, quavers in its refrains, varies its theme with infinite *capriccios*, and shows itself so truly an inspired artist that, after the nightingale, the palm must be awarded to it among our birds of song.

The linnet, also, inhabits our gardens and orchards and builds its nest, by preference, in the well tufted hedges that serve to fence them. Its song is naturally lively and varied; but it is, moreover, a bird that is easily tamed, and which, when confined with other birds, very quickly learns to imitate them. It must be

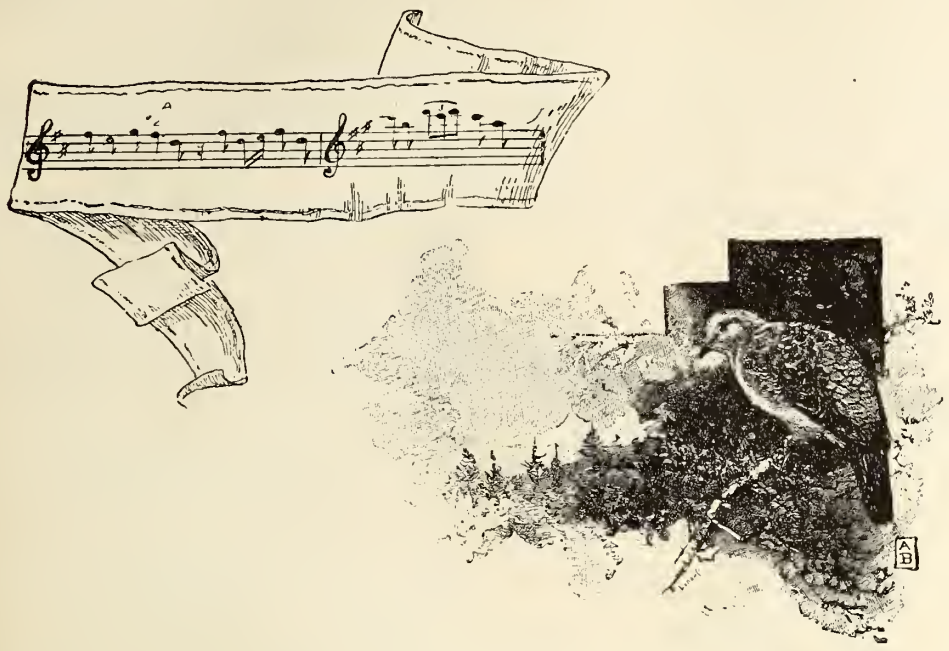


Fig. 5.—SONG OF THE RING-DOVE.

Fig. 6.—SONG OF THE THRUSH.

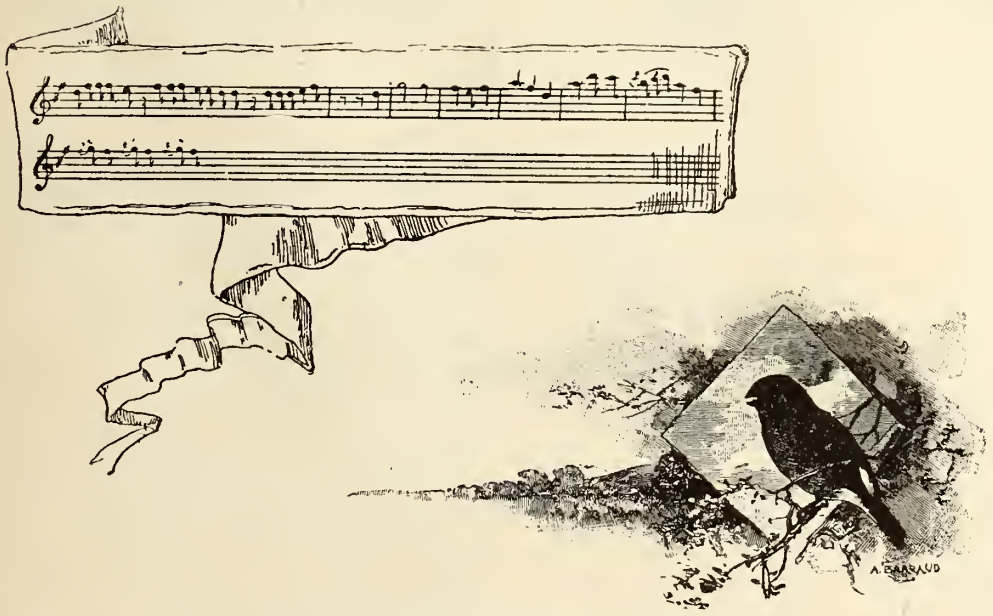


Fig. 7.—SONG OF THE BULLFINCH.

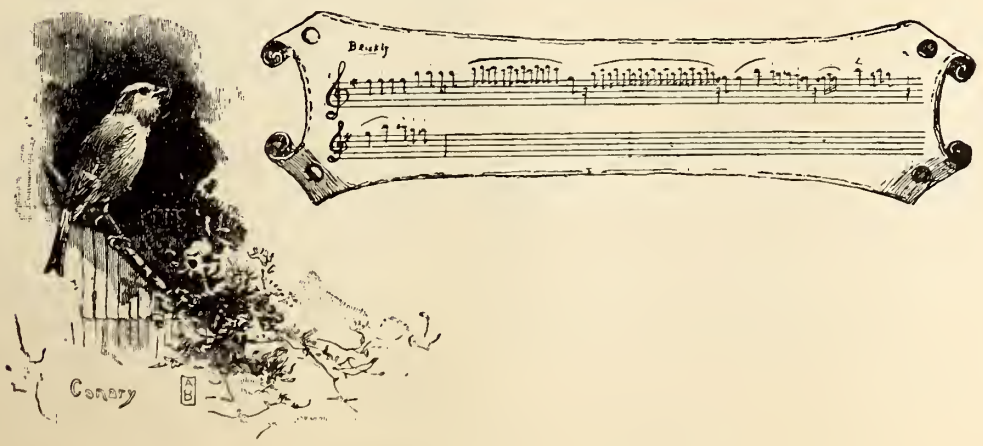



Fig. 8.—SONG OF THE CANARY BIRD.

added, however, that the song that it sings while caged is never so agreeable as that which it repeats in a state of liberty.

In this respect, it somewhat resembles the blackbird, which readily becomes accustomed to its prison, and which easily remembers the airs that are taught it, but the natural song of which is far preferable to anything that the science of the ablest professors can teach it. The blackbird is not generally appreciated as it deserves to be. We observe in this bird only a black plumage, an unsociable disposition and a vulgarity that attracts no attention. Nevertheless, it is one of our ablest songsters, one of the virtuosos that we never hear without pleasure, and which in the grand concert of the groves fulfills its part with a spirit full of lyricism. Winter is not yet over when it, along with the song thrush and the skylark, is one of the first to salute the return of the sun with its limpid and sonorous notes. Its music starts with the first

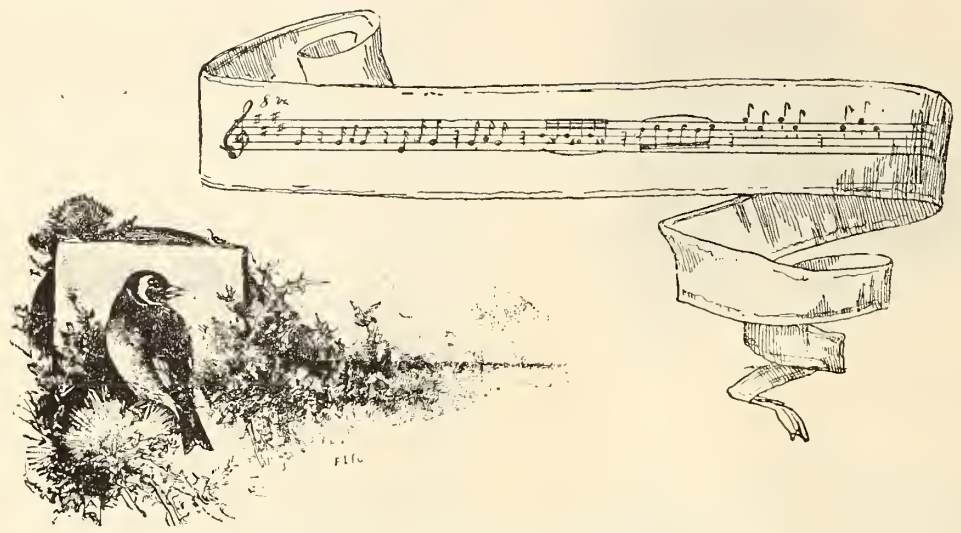


Fig. 9.—SONG OF THE GOLDFINCH.

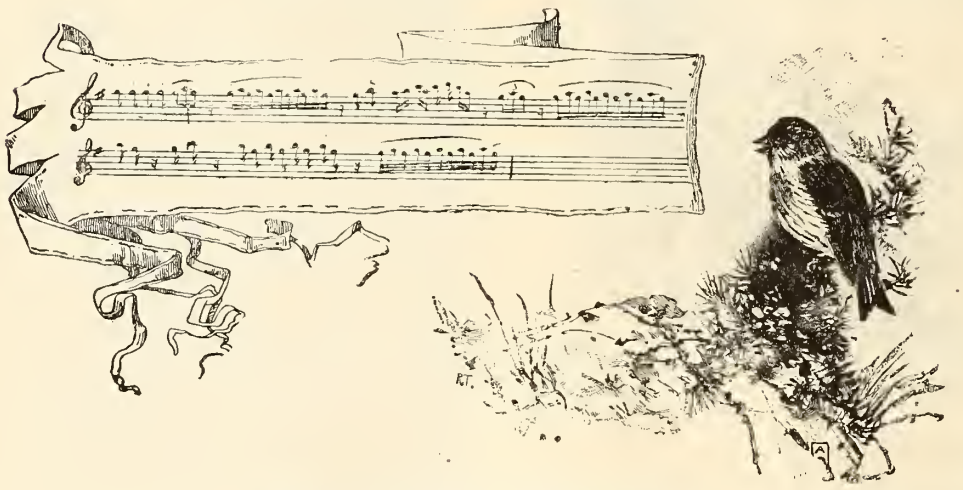


Fig. 10.—SONG OF THE LINNET.

Fig. 11.—SONG OF THE BLACKBIRD.

pleasant days of February. When spring arrives, it celebrates it with its warbling, which it prolongs far into the fine season while many others are silent. It is a dilletante whose throat is always ready, but, like all true musicians, it has its hours of harmony. It reserves its richest accords for morning and evening and also for its mate and her brood. These it enchants for hours at a time without interruption. At the latter end of the season only, it preserves silence, or to speak more correctly, no longer utters anything but a calling cry.

We have accompanied the estimate of the song of some of our birds just given with an attempt at a musical notation of them Attempts at notation, poetical or popular translations and various appreciations often belong, one or another, to the domain of pure imagination. It will be admitted, however, that such observations sometimes present a certain interest and that they offer their little share of curiosity and physiological research.—*La Science en Famille.*

## FACTS ABOUT SUGAR.

By Robert Mitchell Floyd.

When we know that only four centuries ago, during 1497, appeared the first authentic account of sugar being introduced into England, we cannot but marvel at its cheapness of production and universal use by all classes and peoples

Like many other things in everyday use, its early history is very vague, and though ancient Jews are credited with having knowledge concerning it, yet no mention of sugar whatever is found in the Scriptures. All writers seem to agree that the candied or granulated particles, resulting from boiling the juice of a reed or grass—sorgho, now known as sorghum or Chinese sugar cane, *Sorghum nigrum* were first used in the Celestial empire and date back prior to all records, and was in use many centuries before it was in use in India or Arabia. Among the Grecians, at a very early date, it was used in medicine and spoken of as the very costly drug "Indian salt."

Later on sugar confections were received from Arabia and Persia at Rome and Greece, but were held at so high a value that they were only used on very rare occasions by the most wealthy citizens. It is said Nearchus, one of Alexander the Great's admirals, while in the East Indies, 325 B. C., discovered large quantities of sugar, which he brought over with him.

Pliny also mentioned sugar in his writings as "a kind of honey from cane," and many curious stories have come to us regarding the penetrating into the jungles of Arabia, by the early explorers, in the hope of finding "honey grass."

As early as A. D. 625 sugar was brought from Asia, and in 1150 it is mentioned as being received in large quantities in Europe. It is supposed that about 1138 seed cane was introduced into Sicily, and in 1420 cultivation was attempted in Spain and Madeira. Early following the discovery of America seed cane was sent to San Domingo, where it was successfully raised, and in 1510 plantings were sent to Brazil and to the Barbadoes.

The introduction of sugar cane into the United States, or that part of it now known as Louisiana, must be credited to the Jesuit priests who came from San Domingo in 1751. In 1758 the first plantation and sugar mill was established on the present site of the city of New Orleans by Monsieur Du Breul.

No material progress was made until 1794, when the revolution in San Domingo brought to Louisiana a number of refugee planters and their slaves, and with them a superior species of cane, known as the Creole, which was only grown in the French islands. To these men we owe the first progressive movement in this industry.

In 1805 plantings of sugar cane were made in Georgia by Gen. Oglethorpe, whose success drew the attention of planters throughout his State and Florida.

The name "sugar" is Eastern in its origin, as shown by: Persian, shakar; Hindostanee, schukar; Arabic, sakaar, sokkar.

At the time of its early introduction into England sugar was written sugre. True sugar is largely produced from sugar cane—*Saccharum officinarum;* sorghum, *Sorghum nigrum;* sugar beet or mangel-wurzel, *Beta vulgaris;* sugar maple, *Acer saccharium.*

We use the term "true sugar" in distinction to the chemical results produced from many different materials; as, for instance, starch, changed by and to a sweet substance and called glucose or grape sugar, and others known as sugar of lead, sugar of milk, sugar of malt, sugar of manna, etc.

The growing sugar cane in our Southern States is not unlike our common field corn, with its tall stalks and long, waving green leaves. It is planted in rows about four to six feet apart, from cuttings of the cane—not from seed.

During the last part of October the cane is ready for harvesting; then the exciting period of a sugar plantation life begins, for as frost is expected at any moment, and as it kills the cane, as far as sugar making is concerned, all work is done with a rush. At daybreak swarms of negroes enter the fields, each armed with a sharp cleaver-like knife; with its back they break off the tough leaves and then, with a quick stroke, the stock is cut close to the roots and thrown to the ground, where it is picked up by the women, whose duty it is to gather and to carry it to the teams, which wheel it away to the grinding mills. The grinding consists of running the stalks of cane between huge iron rollers and is conveyed through pipes to the boiling rooms, where the first process of sugar making is begun.

From the time the first cane is cut and until all has been carted in there is a fever of excitement among the workers which seems even to stir into action the sleepy mules. Every one is happy, the sick and convalescent, both white and black, all throng to the boiling room to drink the sweet, delicious juice of the cane and also the warm sirup liquid from the kettles, which is supposed to kill all the ills that are known to be.

More than one hundred years ago a Louisiana poet wrote his appreciation of the cane juice and its benefits to man:

"While flows the juice mellifluent from the cane,
Grudge not, my friend, to let thy friends each morn,
But chief the sick and young at setting day,
Themselves regale with oft repeated draughts
Of tepid nectar; so shall health and strength
Confirm thy negroes and make labor light."

—*American Grocer.*

## PURIFICATION OF SEWAGE AND OF WATER BY FILTRATION.

A paper upon this subject, prepared by Hiram F. Mills, A.M., C.E., for the International Engineering Congress at Chicago, contains so much that may be put to practical use wherever artificial means are necessary for a sufficient supply of pure water that we reprint the most important parts of the paper from the *Transactions of the American Society of Civil Engineers.*

Six years ago the State Board of Health of Massachusetts began experiments to supply the deficiency that was found to exist in the knowledge of the engineering profession upon the subject of filtration of water and of sewage. The ends in view were the prevention of pollution of streams, the purification of domestic water supplies and the general preservation and improvement of the public health.

The objects were not to make a better looking water or one that would be better adapted for use in steam boilers or for certain manufacturing purposes, but to learn the best methods of removing those impurities in drinking water that may be injurious to health, and, if possible, to purify sewage, so that the effluent may with safety be turned into a drinking water stream.

To supply knowledge upon these points and others pertaining to the purity of water supplies, the Experiment Station of the State Board of Health of Massachusetts was established at Lawrence in 1887. Some of the more important general results of the six years of careful investigation will now be presented.

Some idea of the extent of the laboratory work in the Department of Filtration may be conveyed by the following statistics:

There have been analyzed chemically:

1,700 samples of sewage applied to filters;
6,400 samples of effluent from filtered sewage;
400 samples of water applied to filters and
970 samples of filtered water; also,
611 samples of substances applied to filters and flowing from them, for the purpose of determining the effect of filtration upon various substances contained in sewage, making a total of 10,081 chemical analyses of samples connected with filtration.

Bacterial samples of sewage and effluent corresponding with 6,770 of the above chemical samples were examined, and about 4,000 such samples which were not examined chemically. Nine thousand other bacterial samples were examined in connection with filtration.

Samples of sand used in filters examined for bacteria numbered 880, making a total of 20,650 bacterial

examinations connected with filtration. There have been made 3,700 comparative species determinations of the bacteria in water before and after filtration.

When this work was commenced it was definitely known that no nitrification or complete oxidation of nitrogenous organic matter would take place without a current of electricity or the presence and co-operation of organic life. Robert Warington had found by numerous ingenious experiments that nitrifying organisms were to be found abundantly in soil, and it had been concluded that soil was essential to a filter bed; but the experiments of the State Board of Health show that nitrifying organisms are contained in the several kinds of drinking water supplies of all parts of the State and probably in all sewage, and that into filter beds of sand or gravel containing no soil they are after a short time introduced in sufficient numbers by the sewage; hence that soil is unnecessary for this purpose.

Organic life alone cannot produce nitrification; there must be present free oxygen. Unlike most drinking waters, sewage contains no free oxygen, if any air enters it, the oxygen is absorbed by the carbon of the organic matter; and in order that nitrification may take place there must be provided an excess of oxygen beyond that which will be readily taken up by the carbon.

The circumstances that bring most clearly to mind the essential conditions of intermittent filtration are these: a bed of gravel stones as large as robins' eggs, having an abundance of nitrifying organisms attached to each stone, has sewage poured over it for a short time; after the sewage has settled away, every stone it has reached is covered with a thin film of liquid in contact with air and enveloping the nitrifying organisms. Then nitrification takes place rapidly and with great completeness. A single hour will make a marked change in the character of the adhering liquid.

After a few hours another charge of sewage distributed over the filter will mingle somewhat with the former adhering liquid and cause it to move downward. If this charge is too abundant, a part of it may flow too rapidly through the large interstices between the stones and reach the outlet drains without being completely nitrified. This condition limits the amount that can be purified by coarse materials. The air spaces are larger than necessary, and the area of surface is small. By decreasing the diameter of the stones to one-tenth of their present diameter we may still have the same amount of air and water space and ten times the surface to which the water may adhere. In this case the air spaces between the films, though very much smaller than before, are sufficient to supply the oxygen necessary for nitrification, if we allow sufficient time between applications for the sand to become drained. It is, however, evident that if we continue diminishing the diameter of the grains of material we shall reach a condition in which the films of water adhering to the grains will occupy the whole space; there is then no room for air, and nitrification cannot take place. Sand in a filter bed that remains saturated after draining 24 hours is of little value and may be very objectionable.

Up to the present time the experiments of the State Board of Health indicate that the sand of even grain that presents all of the conditions most favorable for the very complete purification of sewage has a diameter of grain of about two-tenths of a millimeter, or about eight-thousandths of an inch.

The more even in size the grains are the better, but as we rarely find a sand in which some of the grains are not many times the size of others, and as the conditions for nitrification depend more essentially upon the finer grains of the mass, we have found it more intelligible to classify sands by the finer 10 per cent. of their grains, and in thus classifying sands we should say that sand presents the conditions most favorable for very complete purification of sewage, the finer 10 per cent. of whose grains has diameters equal to and less, but not much less, than 0·2 mm.

In soils, the organic matter, which is much finer than this, makes up a considerable part of the finer 10 per cent. of the particles, and this, sticking to the other particles, decreases the air and water spaces to a greater extent than would appear from the mechanical analysis; hence, while a filter bed made of soil whose finer 10 per cent. has diameters equal to and less than $\frac{8}{100}$ mm. will be entirely ineffectual in purifying the smallest amount of sewage, one made of clean sand, whose finer 10 per cent. has diameters equal to and less than $\frac{8}{100}$ mm., may satisfactorily purify for years 30,000 gallons of sewage per acre daily.

With the kind of sand indicated above as being most favorable for very completely purifying the largest amount of sewage, the quantity that may be permanently applied to filters having a depth of 5 ft. of such sand is found to be about 100,000 gallons per acre daily.

The very complete purification here referred to produces an effluent chemically as good as many drinking waters, having in 100,000 parts about 0·0020 part of free ammonia and about 0·0130 part of albuminoid ammonia, the former being but $\frac{1}{10}$ of 1 per cent. and the latter but 2 per cent. of the amount in the sewage. Nearly all of the organic matter of the sewage is burned up, forming in the effluent soluble nitrates to the extent of about 1·8 parts in 100,000. Bacteriologically, the results are even more remarkable, there remaining in the effluent less than 1 in 10,000 of the number applied in the sewage. The appearance of the effluent is that of a bright, clear spring water.

With finer sands similar results may be obtained with decreasing quantities, one-half of the quantity being filtered by sands of whose finer 10 per cent. the maximum grains have diameters of $\frac{5}{100}$ mm., and excellent purification may be obtained with sands so fine as to allow the application of only 25 000 gal. per acre per day. In fact, with the finer sands, having a proper daily charge, the bacteria of the sewage may be more completely removed than with the sand allowing the greatest amount to be purified chemically.

With the material best adapted to the purification of large quantities of sewage, there is a deposit of nitrogenous matter in the upper layers amounting to about 15 per cent. of all of this kind of matter applied in the sewage The other 85 per cent. is oxidized and passes off in solution as nitrates in the effluent. The effect of this deposit on and near the surface is to decrease the air space between the grains of sand and increase the amount of water continually held by these layers; thus in time preventing sufficient change of air in the layers beneath. Continued efficient action may be had by frequently raking over the surface to the depth of 1 in.; but there comes a time when this upper inch should be removed and replaced by clean sand. With the full complement of 100,000 gal. per acre daily of such sewage as has been filtered at Lawrence, the upper layer 1 in. in depth should be replaced by clean sand once in about eight months. With other rates of application of sewage, about 1,000 gal. of sand should be replaced for each 1,000,000 gal. of sewage applied.

The sewage that has been used upon the filters of the Experiment Station at Lawrence is pumped from one of the main sewers above where manufacturing wastes enter, and where the sewage, coming from stores and from the homes of about 10,000 people, may be regarded as ordinary city sewage, including storm water. The sewage is drawn through a cylindrical strainer lying horizontally and diagonally across the sewer a few inches above the bottom. This strainer has many holes ¾ in. in diameter. Lying as it does between the bottom and the top of the stream of sewage, it is probable that the sewage drawn through the pipe does not contain as much of the fatty substances floating on the surface of such a stream, nor as much of the mineral matter moving over the bottom, as if the sewage flowed directly from the mouth of the sewer upon the filter, but quite as much of these substances as sewage separate from storm water passed through grease traps and the settling basins usually used with sewage to be filtered.

An average analysis of the sewage put upon the filters in parts per 100,000 would be about as follows: Loss on ignition, 20 parts; fixed residue, 30 parts; free ammonia, 2 parts; albuminoid ammonia, 0·7 part; and chlorine, 6 parts. One-third of the organic matter shown by loss on ignition is in suspension. One-fifth of the mineral matter and one-half of the nitrogenous matter as shown by the albuminoid ammonia is in suspension. The average number of bacteria was 800,000 per cubic centimeter.

With sewage containing more nitrogenous matter in suspension than here given, the upper inch in depth of sand would require to be replaced more frequently than above stated, and with correspondingly less frequency if the nitrogenous matter in suspension were less.

With such sewage as above described an excellent but attainable result during warm weather is an effluent whose analysis has been already given and is now repeated for immediate comparison. Free ammonia 0·0020 part; albuminoid ammonia, 0·0130 part; and nitrogen as nitrates, 1·8 parts, and less than $\frac{1}{100}$ of 1 per cent. of the number of bacteria applied.

To obtain as good a result in a cold New England winter, it is necessary to protect the surface of the filter bed so that it will not freeze. If the sand freezes at the surface, the sewage thaws places here and there and passes too rapidly through the sand in sections, having less than the whole area of the bed; air is partially excluded and nitrification is checked. A closed shed which will keep snow and wind from the bed will be sufficient covering where the sewage used has the ordinary temperature of sewage in sewers of 45° Fah. or more.

Unprotected beds treated with such sewage may be expected to have nitrification very much checked and an increase in organic matter in the effluent shown by the albuminoid ammonia, amounting to three times the quantity found during the warm months, with a larger multiple of the bacteria.

Four such beds through the coldest months removed an average of 91 per cent. of the albuminoid of the sewage and 97 per cent. of the bacteria; but there results from the decrease in nitrification a storing of organic matter in the filter which is only partially removed in the warm months, and the permanence of the filter is somewhat impaired. If filters are to be run nearly to their full capacity, they should be protected from freezing.

Fine sand filters may have their capacity increased by excavating trenches about 5 ft. apart, 1 ft. wide and 2 ft. deep, and filling them to within 3 in. of the top with coarser sand and applying all of the sewage to the surface of the coarse sand. In winter, boards may be put on across the trenches under which the sewage will flow and, being protected from snow, it will not freeze. Sand so fine that 15,000 gal. per acre per day exceeds its capacity may thus be enabled to filter satisfactorily 30,000 gal.

The amount of sewage that may be applied at one time depends upon the size of the grains of sand and the resulting amount of air and of water held after draining. With gravel stones which retain very little water the amount applied at once should not be as great as the amount retained, otherwise some of it will flow through immediately without sufficient time for the chemical changes to take place. On the other hand, fine sands retaining a large amount of water hold but little air; and as sewage needs as much as its own volume of air for its oxidation, we have here the quantity that may be applied at one time limited by the quantity of air held by the filter when the sewage is applied.

As illustrated by the filter of gravel stones, the purification of sewage by intermittent filtration is in no essential degree a straining process; it is essentially exposing the liquid for a sufficient time in thin films upon the surfaces of solid particles having nitrifying bacteria adherent, with air in contact with the films. These are the conditions most favorable for the chemical change, which consists of burning up the organic matter and producing the harmless mineral matter which we have called the nitrates. In continuous filtration these conditions do not exist, and no such purification is possible.

It is equally true that the removal of bacteria from the liquid depends only incidentally upon straining; for example, upon straining sewage through filter paper, which is supposed to remove all suspended matter, the number of bacteria remaining in the effluent was 20 per cent. of the number applied, while the number leaving a filter of gravel stones 5 ft. deep was less than 1 per cent. of the number applied when filtering intermittently 80,000 gal. of sewage per acre daily.

Bacteria are killed by subjecting them to conditions on the passage through the filter unfavorable to their life. One very important condition is depriving them, for a sufficient time, of suitable food material. This is most effectually accomplished by burning up the organic matter in the process of complete nitrification; so that, in general, the conditions which produce the most complete chemical purification are those most favorable for the removal of bacteria. It also results that the effluent in which nitrification has been complete is unfitted to support the life of bacteria. On the other hand, water that has been boiled supplies a good food for bacteria, and if such water be treated with a small percentage of unboiled water, the bacteria thus introduced may increase in a few days to a thousand times the number then to be found in the unboiled water. If, when very completely nitrifying the sewage applied to it, a filter be flooded with water from a boiler, the following effluents from sewage will contain a much larger number of bacteria than usual.

It was found that heating the sand of a filter to 300° Fah., or more, and pouring boiling water through it caused 100 times as many bacteria to pass through it with sewage for three months as passed through a similar filter whose sand and first water had not been heated. This appears to be due to preparing the organic matter in the sand and in the water by heat, so that it is a better food for the bacteria.

It has been found that most of the bacteria that get through the filters are of kinds that live and are propagated in wet sands and underdrains. If typhoid fever germs were applied with the sewage, their lateness of development upon gelatine plates allows other bacteria to grow in such numbers or to liquefy the plates to such an extent that the typhoid fever germs, if present, can hardly be distinguished; hence, it becomes necessary to select a foreign species, not found in our sewage, having habits of life similar to typhoid fever germs, that can be readily distinguished from other bacteria; such is *Bacillus prodigiosus* which has been cultivated in large numbers and applied by the millions to the several filters.

With sands whose finer 10 per cent. had grains as large as $\frac{5}{10}$ mm. we have succeeded in passing through a few of the *Bacillus prodigiosus*, and conclude that typhoid fever germs would pass through such sands in very much reduced numbers.

With sands of $\frac{5}{10}$ mm. and less we have not succeeded in finding in effluents any of the large numbers of *Bacillus prodigiosus* applied with the sewage. These results, together with the fact that typhoid fever germs continually decrease in numbers, not only in the effluents from these filters, but even, although less rapidly, in sewage polluted waters which have not been filtered, dying out in the latter in from one to three weeks, give us confidence in concluding that filters made with these finer sands, so long as they are kept in a condition to very completely nitrify the sewage applied, will give an effluent that may with safety be turned into a drinking water stream.

Study of the working of intermittent filters shows them to be not mechanical strainers, but delicate organisms gradually growing fitted to perform the work required of them, needing time to adapt themselves to any marked change in the amount or quality of the organic matter applied to them, but regularly, and for many years, performing an astonishing amount of chemical and biological purification, if the essential conditions for their action are maintained.

*Filtration of Water.*—The principles of the purification of sewage by intermittent filtration are applicable to the purification of polluted water supplies, with this important difference: water supplies have not sufficient organic matter to combine readily with all of the oxygen the water absorbs from the air, consequently they contain more or less free oxygen; hence, they do not require so frequent renewal of air in the sand, and much larger quantities can be passed through the filter and find there a sufficient additional amount of air to combine with what nitrogenous matter they contain, to nitrify it through longer periods of continuous use than the still more polluted water which we call sewage.

We may in a very general way distinguish between the two by saying sewage contains fifty times as much nitrogenous organic matter as a polluted water supply. The question may then arise, can we satisfactorily purify by filtration fifty times as much water as sewage upon the same area? It may prove to be practicable in the future, but at present we will give attention to results that have been obtained when filtering about half of this amount.

One of the first steps in considering what sand to use in a filter is to determine how much water will flow through it with the available head. Mr. Allen Hazen, the chemist in charge of the Experiment Station, found the quantity that would flow through the sands ordinarily used for filtration* to be, at a constant temperature, directly proportional to the acting head, and inversely proportional to the depth or distance through the sand. He also found it directly proportional to the square of the maximum diameter of the finer 10 per cent. of the sand grains. Calling the maximum diameter in millimeters, $d$, the head and feet, $h$, the distance flowing through the sand, $l$, and the quantity in 1,000,000 gallons per acre per day, Q, he found the following

* Mr. Hazen also made a few experiments to aid in determining the amount of coarse material necessary for underdraining the sand, which may be summarized as follows:

QUANTITY OF WATER FLOWING THROUGH GRAVEL STONES AT DIFFERENT HEADS.

| Loss of head in terms of distance through gravel. | Size of gravel stones in millimeters and inches. The finer 10 per cent. finer than— | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Millimeters. | 3 | 5 | 8 | 10 | 20 | 30 | 40 | 50 |
| Inches. .... | 0·12 | 0·20 | 0·32 | 0·39 | 0·79 | 1·2 | 1·6 | 2·0 |
| | Quantity flowing in 1,000,000 gallons per acre daily. | | | | | | | |
| 0·0005 | .... | 4 | 12 | 22 | 35 | 90 | 170 | 280 | 410 |
| 0·001 | .... | 7 | 23 | 43 | 65 | 160 | 300 | 480 | 690 |
| 0·002 | .... | 15 | 43 | 84 | 120 | 300 | 490 | 720 | 1040 |
| 0·004 | .... | 29 | 83 | 160 | 230 | 520 | 790 | 1070 | 1360 |
| 0·01 | .... | 72 | 185 | 320 | 420 | 890 | 1280 | 1670 | 2150 |
| 0·02 | .... | 136 | 320 | 500 | 630 | 1280 | 1800 | 2310 | 3030 |
| 0·05 | .... | 300 | 600 | 950 | 1140 | 2030 | 2862 | 2734 | 4800 |
| 0·10 | .... | 530 | 1000 | 1400 | 1650 | 2850 | 4044 | 5280 | 6800 |

formula to satisfactorily express the results of his experiments with water at about 50° Fah.:

$$Q = \frac{800\ h\ d^2}{l}$$

The sand which we have found capable of very completely purifying the largest quantity of sewage having $d$ equal to $\frac{2}{10}$ mm. would, when 1 ft. deep and with 1 ft. acting head, allow 32,000,000 galls. per acre to flow through it in 24 hours; and the same quantity would flow through any other depth if the acting head were equal to the depth. There are practical considerations that make it desirable to depend upon a less head than the distance the water passes through the sand. If there be 1 ft. acting head for a passage of 5 ft. through the sand, the maximum quantity that would flow through this sand in 24 hours would be 6,400,000 galls. per acre; but the whole 24 hours would not be available if the water be applied intermittently. With the Merrimac River water used in the experiments it was found that filling the sand with air once a day was sufficient; in which case we can count upon a steady flow through the sand for two-thirds of the 24 hours, thus passing 4,300,000 galls. per acre per day when the sand is clean; but this quantity would be still further reduced, for the water has some organic matter and some mineral matter in suspension at all times, and during the spring freshets the amount of mineral matter is very large. All of this suspended matter tends to clog the interstices of the upper layer of the filter and to allow less water to pass; hence, the sand of the filter must be coarse enough to allow the desired quantity to flow through when the upper layer is obstructed, and not make the intervals between scrapings of the surface to remove this deposit too inconveniently short.

With the water used, the sand we are considering allowed 60,000,000 galls. of water to pass through 1 acre between the times when it was necessary to scrape the surface and remove about ½ in. of sand and sediment and replace with clean sand.

When filtering 2,000,000 galls. per acre daily, the deposit had to be removed once a month in the six months from May to October, and more frequently during the spring and fall freshets. With coarser and finer sand the amount passed between scrapings was nearly in proportion to the size of the sand grains.

Sands, the larger grains of the finer 10 per cent. of which are from $\frac{1}{10}$ to $\frac{3}{10}$ mm. in diameter, and whose capacity to pass water through a depth equal to the acting head ranges from 8,000,000 to 72,000,000 galls. per acre in 24 hours, have given excellent results when filtering 2,000,000 galls. per acre per day, and the mean of these sizes has also satisfactorily purified 3,000,000 galls. per acre per day.

With filters having 5 ft. in depth of sand, whose finer 10 per cent. had maximum grains from $\frac{1}{10}$ to $\frac{2}{10}$ mm. in diameter, the chemical purification, when filtering at the rate of 1,250,000 to 2,000,000 galls. in 24 hours, was very satisfactory, both with continuous and with intermittent filtration. The following are average results in parts per 100,000:

| | Free ammonia. | Albuminoid ammonia. | Nitrogen as nitrates. |
|---|---|---|---|
| Unfiltered water from the river ... | 0·0070 | 0·0187 | 0·0119 |
| River water filtered continuously.. | 0·0008 | 0·0078 | 0·0251 |
| River water filtered intermittently. | 0·0007 | 0·0075 | 0·0468 |

As before indicated, there is in drinking water nearly enough absorbed oxygen to combine with the nitrogenous organic matter to burn it up or to nitrify it, when it is brought in contact with nitrifying bacteria under conditions favorable for their action. Filling the sand with air once a day furnishes the additional quantity of oxygen necessary for very complete nitrification.

Similar chemical results may be obtained with filters having sand 4 ft. deep. With less depths the purification is less complete, but even with a depth of only 1 ft. of sand the free and albuminoid ammonia were reduced to 21 per cent. and 52 per cent. respectively, of the unfiltered water, and the nitrates were nearly doubled; still, these shallow depths cannot be depended upon to give constantly reliable results.

While the chemical change that takes place in the water when passing through the filter is important, it is much less important than the removal of bacteria. One very important effect of burning up the organic matter and forming nitrates is removing the food supply that would support the life of injurious bacteria. It is probably fair to state that the invisible vegetable kingdom of bacteria is as a whole no more injurious to man than the whole of the visible vegetable kingdom. As in the latter there are certain poisonous plants, so in the former there are a few species that cause disease in man. Of these we know but little, but as far as studied we do not find that they increase in sewage-polluted water. The temperature and food supply they find in the human body are better adapted to their propagation, and while they continue for a time to exist when turned with sewage into a stream or pond, it is probable that they continually decrease in numbers.

With the intelligent care and favorable conditions at the Experiment Station less than ½ of 1 per cent. of the applied germs live to get through the water filters, with sands varying in depth from 1 ft. to 5 ft., and, within this limit, the deeper filters and the finer sands allow smaller numbers to pass.

The difference in the efficiency of removing these applied germs with sand 1 ft. deep, or with sand 5 ft. deep, is so small that it is evident that nearly all of the removal is effected by the upper foot of material. In fact, in a filter having 1 ft. in depth of sand which had been filtering continuously for six months the surface was scraped, and in the next ten days more than 2,000 million of *Bacillus prodigiosus* were applied from day to day. The sand was then carefully examined and found to contain 13 per cent. of the number applied, 93 per cent. of which were found in the upper ¼ in. None were found alive below the upper inch. This was not the case with the ordinary river bacteria; they were distributed throughout the sand, but with greatly decreased numbers below the upper inch.

With intermittent filtration of water, the number of germs remaining alive in the sand is very much less than with continuous filtration. Some examinations in the summer have shown the number in the upper ¼ in. to be but 1 per cent. of the number that had been applied. The ordinary river bacteria do not survive within the sand in intermittent filtration to nearly the same extent as in continuous filtration.

Long series of experiments with the filters which we regard as adapted to the filtration of water supplies have shown, immediately after, as well as before, scraping the surface a removal of more than $99\frac{5}{10}$ per cent. of the applied germs, and if all of the disease germs like those of typhoid fever do not increase, but rapidly decrease, in filtered water, we may conclude that the $\frac{5}{10}$ of 1 per cent. of the number applied will do little or no harm.

Such results can only be obtained in actual practice by having the filters constructed with the most intelligent care, having in view particularly that the sand shall be so placed that it forms a homogeneous mass without stratification or coarse-grained channels down through which an undue quantity of water may flow; and when in use the surface should be as intelligently kept in order, so that every square foot shall continually do its allotted part of the work.

## A UNIVERSAL ASTRONOMICAL CLOCK.

Thinking that a device giving the hour of all the countries of the world, instantly and without calculation, might prove of service, Mr. A. G. Jourdan has constructed the apparatus illustrated herewith. It consists of a terrestrial globe upon which the points figuring the cities are very apparent, so that they can be easily found at a glance. This globe rests upon a dome whose base is divided, parallel with the equator of the sphere, into twice twelve consecutive hours, and graduated in the direction of the rotary motion of the earth, that is to say, from west to east. Half of this universal dial is white and represents the hours of the day, and the other half is black and represents the hours of night. The globe, which is moved by clockwork inclosed in the dome, makes a complete revolution around its axis in twenty-four hours. The clock is wound up every eight days.

It results from this arrangement that when any point of the globe is situated exactly over its local hour, all the other points are necessarily opposite the hour that corresponds to them, and it continues to be

JOURDAN'S UNIVERSAL ASTRONOMICAL CLOCK.

thus as long as the globe regularly accomplishes a revolution of twenty-four hours around its axis.

The gilded hand, L, indicates the local hour and corresponds to a gilded meridian, I, which passes through the place that one inhabits. When we desire to know the hour of any city whatever, we bring this city in front of us by slowly revolving the entire apparatus (which pivots upon its base). We then place the right limb of the silver plated meridian, M, which is movable and independent, upon the center of the city, and the silver plated needle, $m$, with which it is provided points out exactly the mean hour of it. The words "day," "night," "morning," "evening," "noon" and "midnight," indicate the moment of the day under consideration, which is designated, moreover, by the color of the dial, all the countries over the white part being necessarily in the light of day and those over the black part being in the darkness of night.

This universal clock can be used in any part of the globe; for it suffices that the hand of the local hour, which can be displaced at will, shall correspond exactly to the place that one inhabits. A gilded circle divided into 360° represents the equator, whose 0 is fixed upon the local meridian, so that the longitudes can, at will, be counted from any point whatever for an initial meridian. The movable and independent meridian, M, indicates the latitudes and zones whose separations mark the tropics and polar circles. The longitudes, whose hours are indicated by the needle, $m$, of the movable meridian, are read upon the equator at the crossing of the graduated limb of such meridian.

The same apparatus, without clockwork, may serve for furnishing the same data (save the local hour) by setting it previously, by hand, at the hour of the place that one inhabits. Aside from the other services that it is destined to render, its utility for teaching is indisputable.—*La Nature.*

The Mormon Tabernacle in Salt Lake City is the most perfect whispering gallery in the world. The dropping of a pin into a silk hat at one end of the huge structure is distinctly heard by persons at the other end.

THE

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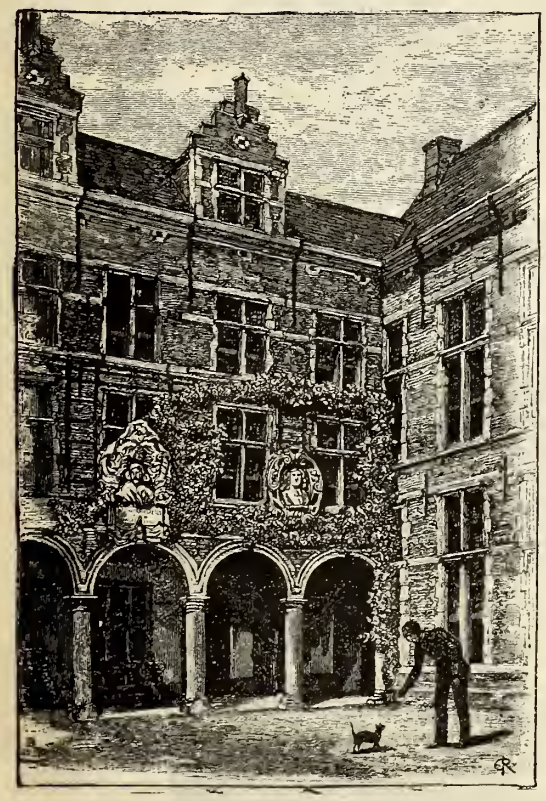
## THE PLANTIN MUSEUM, ANTWERP.

Although printing, according to Mr. William Morris, is not an essential art, it is an essentially interesting one; and, seeing the part it has played in the fixing of our language, with its consequential influence on our character, the origin of the art must always possess an interest to Englishmen. Although he had no hand in the invention of printing, Christopher Plantin was one of the most famous fathers of the art; and it was his remarkable destiny to establish a printing office which endured to within a few years of the present time.



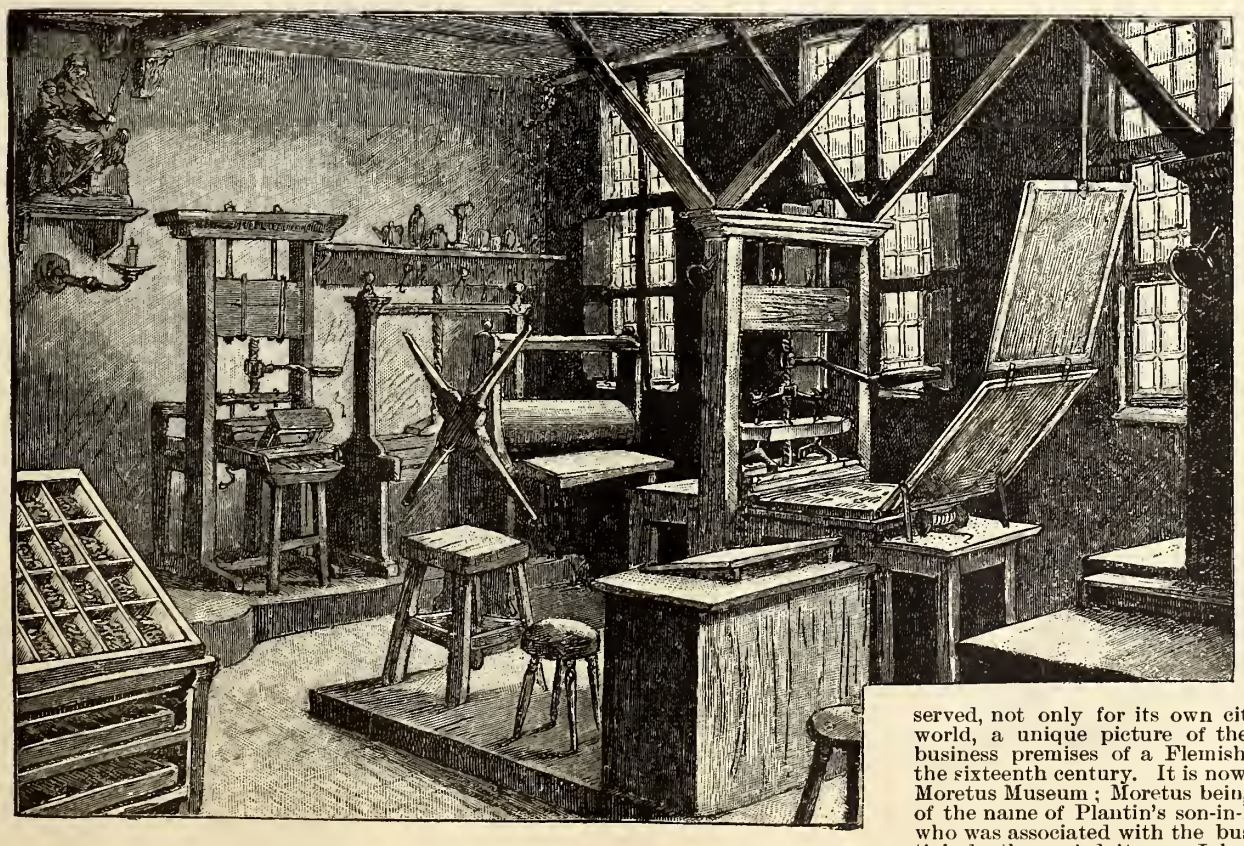
PLANTIN MUSEUM—THE COURTYARD.

Christopher Plantin was born at Tours in the year 1514, and went, when a lad, to Paris to study. His father, owing either to negligence or poverty, left the young man to his own resources, and he consequently bound himself apprentice to a printer at Caen. After his marriage he went to Paris and perfected himself in the art of binding and leather working. At the age of thirty-five he established himself as a bookbinder and leather coffer maker at Antwerp, at that time the most flourishing city in the northwest of the Continent. He soon made a reputation as a clever worker in leather, and his embossed and gilt work surpassed in beauty all that had previously been done in the Netherlands. While taking home a coffer made for the secretary of Philip II. of Spain, he was attacked in mistake by some masked revelers, and so wounded that he was rendered thenceforth incapable of working at his trade as a binder, and so took up again the profession of a printer, which he had practiced at Caen. Some five years previous to this, when enrolling himself as a citizen of Antwerp, Plantin had joined the guild of printers; which shows that, although he practiced leather working, he always regarded as his real business that art which was destined in succeeding years to bring him so much fame. The first book which he printed is dated 1555, and is entitled "La Institutione di una fanciulla nata nobilmente," and, besides the Italian text, it contains a translation into French. In the preface Plantin formally announces it as his first book. For the next seven years comparatively few books were published by him, and the progress of this epoch, though real, was modest. In 1562 he was accused of printing an heterodox pamphlet; and, though nothing unorthodox could be found in his conduct, three of his workmen were sent to the galleys, and he himself deemed it prudent to retire to Paris for a year. A little later, however, he resumed his business by entering into partnership with some friends, and was thus enabled to greatly extend his trade.

Although Plantin seems to have been a man of pretty liberal ideas, and notwithstanding his undoubted association with Jansen and other men of the time not noted for their orthodoxy, he supported the Catholic church and that infamous wretch the King of Spain. Indeed, from 1567 he found his chief support in Philip II. and his ministers, Cardinal Granvelle and Gabriel de Cayas. By the favor of the latter he obtained the privilege of publishing the "Royal Bible," which was printed in five languages. This book, known as the Polyglot Bible, was Plantin's chief work; and, indeed, we may say it was the most important work that was ever printed in the Low Countries. The King of Spain advanced the sum of 21,200 florins toward the enormous expense of printing this Bible, and sent one of his chaplains, learned in languages, to supervise the translations and correct the proofs of the sacred text. The production of this work occupied about five years, during which time Plantin also printed his first breviary and missal, after the versions authorized by the Council of Trent. The Pope's printer having the sole right to publish these books, Plantin made an agreement with him by which, on giving the Italian publisher one out of every ten copies, he was allowed the privilege of selling these books in the Netherlands. In 1570, however, Philip II. granted Plantin a monopoly for the printing of mass books and prayer books for the whole of the Spanish dominions. This privilege not only freed Plantin from his obligation to the Italian publisher, but laid the foundation of the future prosperity of his printing house. From 1572 missals, breviaries, psalters, antiphonaries, the offices of the Virgin, and other prayer books, in all editions, were issued in thousands by the Antwerp establishment.

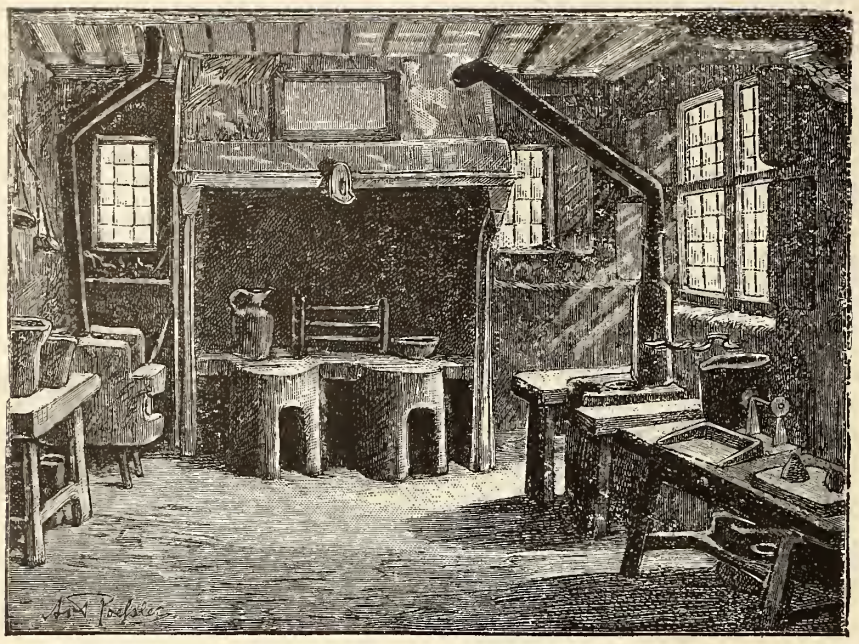
But, notwithstanding these royal favors and privileges, the already famous printing house was destined to suffer many reverses. The revolt of the Netherlands brought trade to a standstill, money was scarce, Plantin's books stayed on his shelves, and he was forced to sell at a loss quantities of books, materials, and goods, to pay the extortionate levies of the Spanish government. Indeed, he got into debt, and was forced again to desert the house which had been the scene of so many labors and triumphs. In 1584 Plantin fled to Leyden, remaining there until the following year. Upon Antwerp being taken by the Duke of Parma, he once more returned thither. When Philip II. charged Plantin with his enormous undertakings he had promised him ample subsidies, and on the completion of the Polyglot Bible had conferred on him a pension of 400 florins. Unfortunately for him, the king's exchequer was in a still worse condition than his subject's, and he never received his annuity, nor did he ever get a penny of the enormous sum due to him by the king at the time of his death. After the sack of Antwerp, in 1576, Plantin had to retrench his expenditure, and, accordingly, he occupied only half of the building which is the subject of our illustrations. But in 1579 he bought the other half, and from that day until quite recent times this most interesting house has been occupied as a printing establishment by Plantin and his descendants and successors.

PLANTIN MUSEUM—THE LIBRARY.



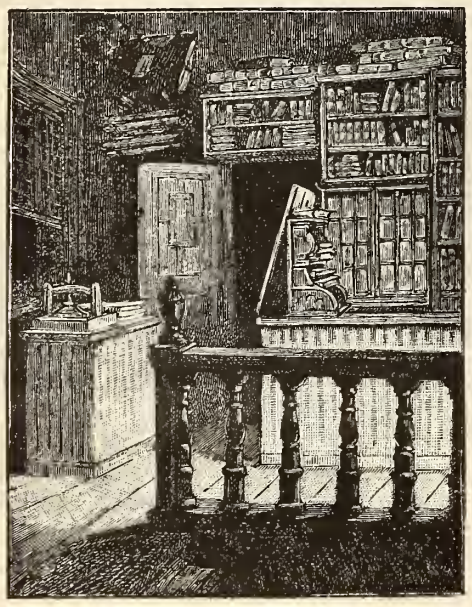
THE PLANTIN MUSEUM—THE PRINTING ROOM.

The monopoly of printing prayer and church service books was withdrawn from the firm in the year 1800, when the premises were temporarily closed as a printing office, and afterward it was used for that purpose only at intervals down to 1875. In that year the city of Antwerp, with most commendable public spirit, bought the building, with its antique furniture and splendid family portraits, its printing materials, machinery, and appliances, and all the stock in trade contained on the premises. By this praiseworthy and timely act Antwerp has preserved, not only for its own citizens, but for all the world, a unique picture of the dwelling house and business premises of a Flemish trader of the end of the sixteenth century. It is now known as the Plantin Moretus Museum; Moretus being the Latinized form of the name of Plantin's son-in-law, John Moerentorf, who was associated with the business, and after Plantin's death carried it on. John Moretus followed in the traces, and respected the traditions of his father-



THE PLANTIN MUSEUM—THE TYPE FOUNDRY.

in-law; and, fortunately for us, his successors continued the same policy and made but few alterations either in the appliances or the building. Thus to-day we have the implements, the materials, and the produce of this famous mediæval printing establishment and the furniture of a prosperous burgher's house pre-

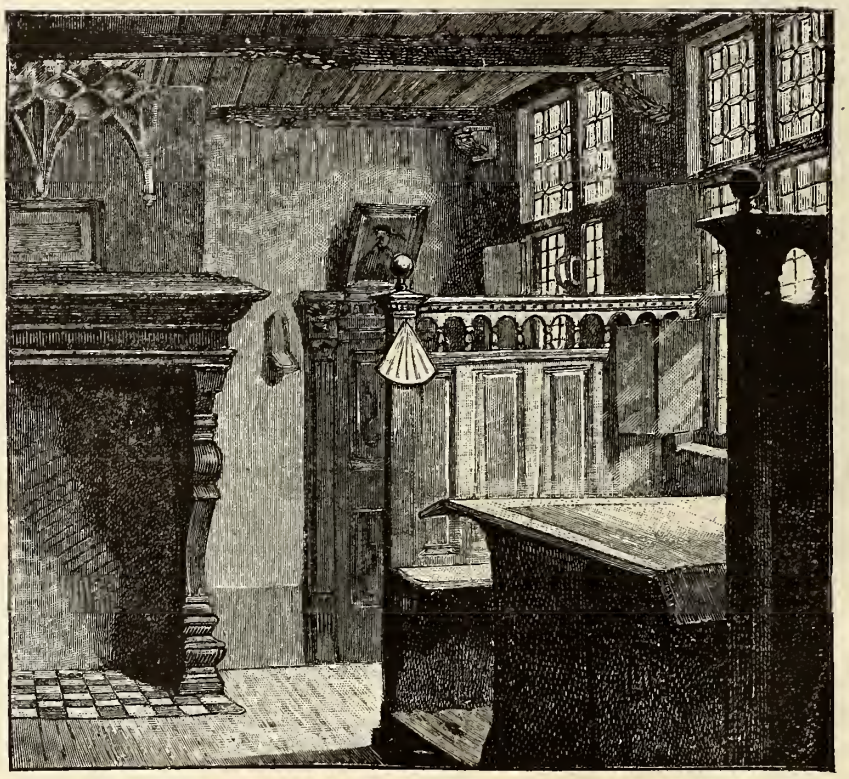


THE SALE ROOM.

served to us, and arranged pretty much in the very way that they were when the Moretuses lived in the house and directed its affairs. This famous and attractive museum is situated in the southwest corner of the small Marche du Vendredi, near the beautiful cathedral and the massive town hall, and close to the quays of the River Scheldt. The facade was constructed during the last century, but it did not interfere with the rest of the older buildings, which run round a central courtyard—a characteristic feature of the building. The architecture, which is largely domestic Gothic, with an admixture of Renaissance, is eminently attractive, and the effect, though homely, is artistic and pleasing.

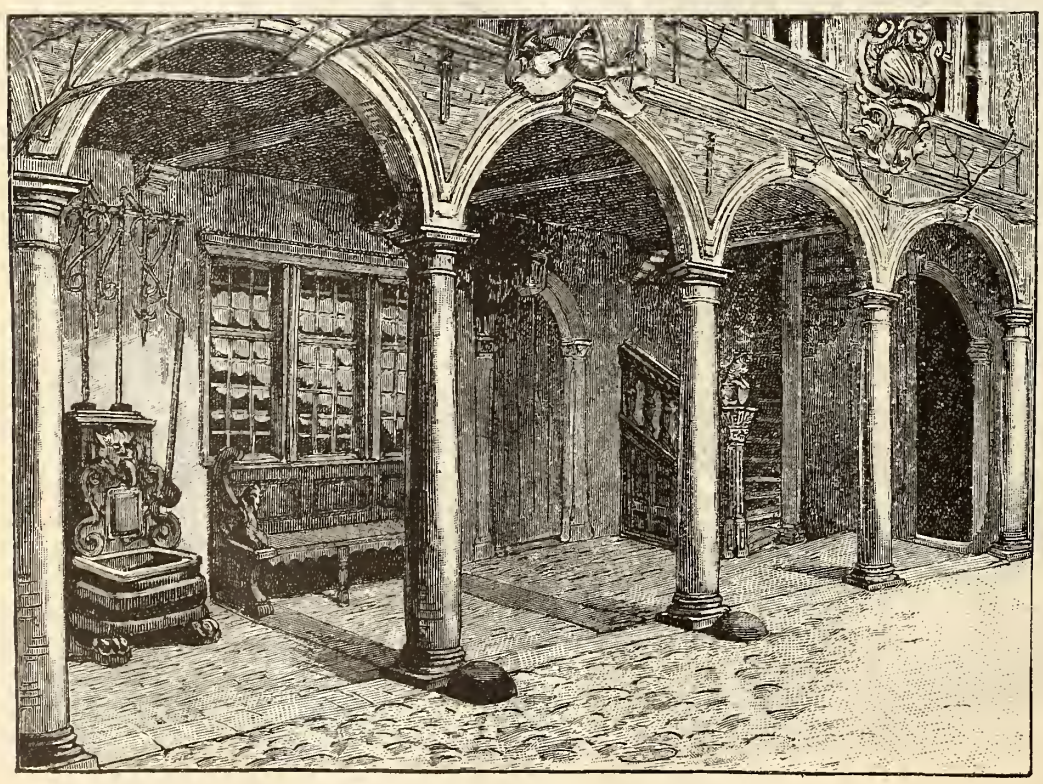
Most of the building is two stories high, with dormer windows in the roof, and an arcade running round three sides of the courtyard. Over the gallery, on the north side, are several busts of the more famous directors of and successors to Plantin's business. Among them is one of Balthasar Moretus II., which dates from 1683. In the corner, underneath these monuments, is seen the staircase built in 1621, with carved rails and pillar surmounted by a lion holding a shield with the arms of Balthasar III., who was ennobled—that is to say, made a "gentleman of coat-armor"—in 1692 by the King of Spain, and obtained the privilege of carrying on his craft without compromising his nobility. Further on are seen an old carved bench and a curious seventeenth century pump of blue marble, with a sculptured bronze spout. On the right of the vestibule is the entrance to the reception rooms, all handsomely and comfortably furnished. The walls are hung with fine old Flemish tapestry, and on them hang many admirable family portraits. Several of them are by Rubens, who not only painted the portraits of members of the household, but designed title pages, frontispieces, and other illustrations for the works printed by Plantin. Indeed, so close was his connection with the family and business that local rumor assigns to him the position of son-in-law to Plantin, though strict historical record does not bear out such a tradition. The original receipts signed by Rubens are still preserved, and show the actual sums paid to that great artist for designs used by the printers. Many of Rubens' vignettes, drawings, and title pages are also carefully preserved under glass cases.

At the end of the mediæval-looking court, one side of which is entirely covered by the branches of an aged vine, are situated the sale rooms, with separate entrance from the side street; they are embellished



THE PLANTIN MUSEUM—THE PROOFREADERS' ROOM.

with old tapestry and oaken paneling. On the other side of the court is the printing office, where everything is now arranged as if work were to be resumed to-morrow. First comes the proofreaders' room, with its little compartments and tables and benches of carved oak. On the desks lie old proof-sheets, first impressions, and other documents, vividly recalling the work of the past. Next to this are the proprietor's office, with gilt leather hangings reminiscent of the craft once so ably practiced by the master, and the so-called room of Justus Lipsius, with Spanish leather hangings, where the great critic and philologist is said to have been lodged while visiting his publisher Moretus. A passage leads hence to the type foundry, with furnaces, matrices, and other old-fashioned appliances for casting type and making the blocks and requirements of the printers' business. Next it is the composing and printing room, which contains, besides the cases of type, two hand presses of the sixteenth century. On the first floor are situate many fine reception rooms, now used as receptacles for books, pictures, engravings, and curios belonging to the family and connected with the business. Further on are the bed rooms, furnished and swept and garnished as if the late occupants were going to return at night. From one of the living rooms a few steps lead into the library, which is a comfortable room, fitted up just as it was in old Plantin's time, and having little resemblance to the more museum-like rooms above, where copies of all works printed by the firm are stored and classified. Other rooms contain hundreds of copper plates after Rubens, Jordaens, Van Dyck, and other artists, together with proofs thereof and numerous fine specimens of early printing. To those who know anything of the typographic art, an examination of these relics of an old printer's business is most fascinating; while to the ordinary tourist the house forms undoubtedly one of the most attractive museums in the world.



THE PLANTIN MUSEUM—THE CLOISTERS.

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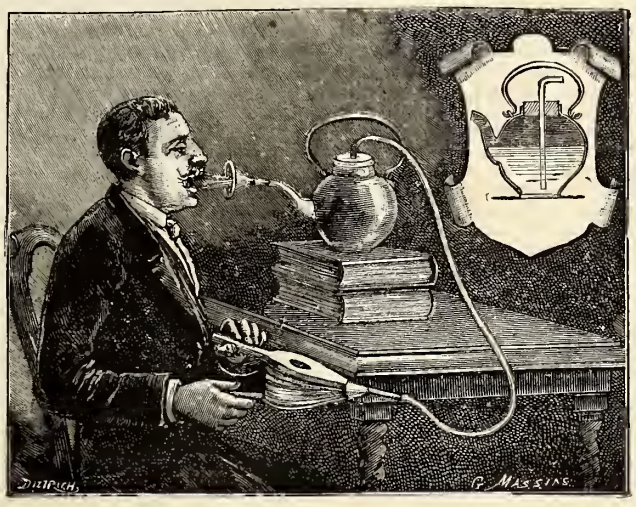
There is one place in the world, at any rate, where the streets are literally paved with gold. At Johannesberg it has been found that stone recently supplied by a mine on the main reef for paving the streets yields six dwts. to the ton over the plates.

## A SIMPLE INHALING APPARATUS.

IN most of the affections of the bronchial tubes or larynx, physicians recommend inhalations of aromatic substances—turpentine, eucalyptus, pine sap, etc. If the treatment is to be but transitory, the patient will perhaps find some advantage in constructing the apparatus designed for such purpose for himself, and will not judge it *apropos* to purchase an instrument that will soon remain without any use.

In many cases the inhalation may be practiced with a simple tea kettle placed upon a chafing dish, and the spout of which is provided with a funnel fixed through the intermedium of a cork or a piece of rubber tubing. But hot steam is often disagreeable, and it is always dangerous to place a chafing dish upon the bed of an invalid.

These two inconveniences may be suppressed by a very simple arrangement. Close the tea kettle with a wooden or cork stopper in which an aperture has been made for the reception of a bent tube entering the liquid. Connect this tube by means of a rubber one with the nozzle of a bellows. A current of air on being sent into the tea kettle by the bellows will cause an energetic bubbling, and, in its passage, will become charged with aromatized steam, which escapes at a temperature at which it is in nowise disagreeable to inhale.



A SIMPLE INHALING APPARATUS.

The advantage of this process is that it is not necessary to cause the water to boil in order to obtain air highly charged with vapor. The inhalation may be begun after the tea kettle has been taken from the fire, and be prolonged until the temperature of the water has reached about 50°.

The tea kettle may be placed upon a bed without any danger, and, if the patient is in a state to work the bellows himself, he can moderate or quicken the flow of vapor at will.

We show the method of using the apparatus in the accompanying engraving. The arrangement that we point out is that which requires the fewest resources foreign to a household; but one might, with advantage, substitute a tubulated retort for the tea kettle and a rubber bulb for the bellows.—*La Nature.*

## WATER GAS IN SMALL WORKS.

THE great growth of water gas throughout the country and the fact that nearly all of the large and medium sized gas companies have adopted it, has made many of the smaller companies debate the question of whether they too might not install it to advantage. In the consideration of this matter, the question very naturally arises as to how much of a change in existing works may be necessary; whether water gas can be easily put in a coal gas works, and, in brief, in what manner it should be arranged. In answer to such questions, and especially as of interest to the smaller companies, we illustrate and describe herewith the arrangement of a typical water gas plant as added to a conventional coal gas works, and that the instance may preferably be one of reality rather than a suppositious case, an actual current example has been selected for description.

The cut is sketched from the works of the Hanover Gas Company, of Hanover, Pa. The water gas plant now in course of construction for it is one of the standard sets for small works of the United Gas Improvement Company's well-known Lowe form, and in view of the many years' experience in design and construction work and the standing of this company, it may be assumed that the arrangement is a correct one.

The old plant may be described as a regular 6 in. coal gas works. To the left, in the cut, is the usual retort house, containing 3 benches of 3's. Beyond it is the purifier house. This side of it (and adjoining) is a coal room extending up to the railroad switch. In addition to the benches, the old machinery comprised a small boiler, a coke scrubber, a vertical pipe air condenser, 4 small boxes, a small meter, and a 16,000 ft. storage holder. So much for the old outfit.

In considering a water gas machine, the first question was, where to put it and avoid the expense of a new building. Two courses were open. One was to locate it in the retort house in the space gained by removing the oldest bench, using the old foundations. As the roof was at the usual height of 16 ft. or 18 ft., this was quite feasible, giving plenty of room. A still better plan, however, was determined upon, which was to locate it the other side of the wall in the coal house, as shown in cut. In this way it was kept out of the dirt of the retort room; the benches were left entirely undisturbed, and the space taken in the coal house caused no loss, for the reason that with water gas not more than half as much coal storage is needed as compared with coal gas.

The old coal gas scrubber was both unsuitable in design and too small to handle the gas from the rapid making new machine; so a new capacious water gas scrubber was supplied and located in the corner, conveniently near the machine proper. Immediately alongside it also was located the new steam boiler (not shown), and in the adjoining room, out of the dust, etc., the engine and blower; so that, in brief, all parts of the new outfit were immediately near the gas maker, enabling one man to easily run everything. From the groups of water gas parts, the gas take-off pipe led directly to the old take-off pipe from the hydraulic main, at which point the two systems connected. This being so, it is at once evident that the arrangement simply made a double-stringed gas works, having two ways of producing gas. Either coal or water gas, or both, could be made at pleasure, the two systems then joining together, and the gas passing on through the works in the old way through the old pipes. Or, even more briefly, it could be covered by saying that the water gas plant was simply added to the coal gas system.

One might naturally suppose that there would then be nothing more to do than to start up and make gas. A very important point, however, was yet to be considered, *i. e.*, that of pressure on the boxes, etc., due to making water gas so rapidly. While water gas, generally speaking, requires no more purification than coal gas, and is purified in precisely the same manner, yet it is evident that while a small set of boxes, as at Hanover, might handle a given make, say 25,000 ft. or 35,000 ft., made in twenty-four hours, if that amount were made and crowded through them in a few hours high pressure would result and trouble might ensue from blowing the seals, or the formation of blow holes in the lime or oxide, allowing gas to pass through unpurified. Further, the same high pressure upon a station meter alters the water levels, and makes incorrect registration. To minimize all such possible troubles, a small second or relief holder was decided upon and put in. This was simply a diminutive but regular gas holder of 3,000 ft. to 5,000 ft. capacity in a wrought iron tank, entirely above ground, involving but a slight expense for foundation, and avoiding all uncertainty of cost of the usual excavated brick tank in the ground.

This holder is so connected that if at any time during a run the water gas machine makes more gas than ought to pass through the boxes, the excess gas will pass into it, and there be temporarily stored until the run is through with. Then, during the time of blowing up, or getting ready for the next run (when no gas is being made), this excess gas in the small holder is passed on through the boxes. In this way the gas passes through them at only half the rate that it is really made by the machine, and the initial intermittent make and high pressure of the water gas does not get beyond the small holder, but is absorbed by it, so to speak. From that point on the gas passes along at a uniform rate and moderate speed through the boxes and meter, and at a low pressure; not exceeding whatever pressure may be given by the relief holder.

To pass the gas, as above, from the relief holder, through the boxes and on into the large holder, several means may be employed. In a small works, such as Hanover, the simplest is to have the small holder heavy enough to force the gas through. Where, however, the general connections are small, or there is much back pressure, this may not be sufficient, and in that case an exhauster is usually used, so connected that it draws the gas from the relief holder and passes it on precisely as though it were drawing from the benches. As most companies already use an exhauster, this means no added expense, and is the arrangement usually employed.

The above method of operating with a relief holder is the most satisfactory method of making water gas, and is always recommended to be adopted where possible by the United Gas Improvement Company, whose apparatus we are considering. It is the preferable method, but that it is not absolutely necessary is shown by the numerous companies making water gas directly through the boxes with only one holder. In such case the purifier seals are deepened, if possible, or arranged with clay, or the paraffine wax device of Mr. Shelton, of the above company, in place of water, to prevent blowing off the seal under the intermittent make and high pressure of direct connection.

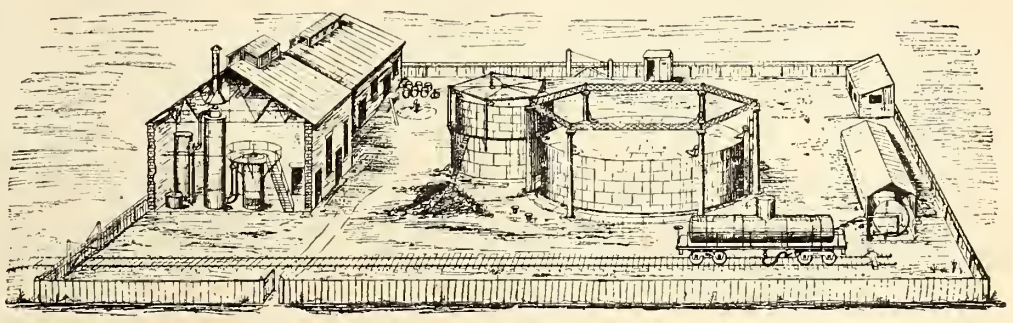
Aside, however, from the question of smoothest operation, in conjunction with a water gas machine, the use of a small holder, as above, affords protection to the works in case of accident or repairs to the main or old holder. At Hanover, for instance, the connections will be so made that in case of emergency, purified water gas can be supplied to the town direct from the small holder. With coal gas, it would ordinarily be quite impossible, with only a 3,000 ft. holder, to maintain the supply during the hours of heavy consumption, but with a fast-producing water gas machine it is quite possible, though, of course, not economical. That this is so, is shown by an instance, known to us, where for years a water gas company has been working with a single 5,000 ft. holder only, though in winter the output reaches 35,000 ft. and even 50,000 ft. a night. This, at least, shows what can be done.

For the storage by small companies of the oil necessary for the manufacture of water gas, various arrangements are followed. An iron oil tank of either horizontal cylindrical form, or vertical cheese box style, may be located out in the air on the sills, or on a pier, or under roof in the coal shed, or in an excavation or pit in one corner of the lot, according to local conditions and individual ideas. The last arrangement mentioned is that at Hanover, as shown in cut, and is undoubtedly one of the best, for while accidents in reality rarely happen to storage oil tanks, and then usually only through the grossest carelessness, yet they are possible, and in case of such contingency– and to satisfy the insurance men—it is better to have the tank somewhat apart from buildings, and in an excavation or pit. Then, in case of accident, the pit, by holding the oil in it, prevents its flowing toward the buildings. Setting the tank in a pit, moreover, gives a fall, often enabling the unloading of tank cars entirely by gravity, so avoiding the use of a pump.

In cases where no railroad switch, as above, exists on the gas premises, a pipe line that may be a half or even a mile in length is run to the nearest siding or point of unloading; or a tank wagon may be used where a pipe line would be of too great length; and it may be added that the cost of procuring oil, even by team hauling, need not exceed a fraction of a cent a gallon. The general arrangement of works and plant outlined above is that followed at Hanover, and is shown in the cut, and behind and to the left of the main gas holder may be seen the new 3,000 ft. holder in steel tank above ground. Excepting for this and the oil house, scarcely an external evidence can be found that the works have been changed from the coal to the water gas system.

As such an essential portion of the typical water gas works described, brief mention of the typical water gas machine itself there installed is not amiss. In form it is the standard of the United Gas Improvement Company for small works, known as the single superheater setting; in distinction from that company's well-known double superheater setting, so generally used in the larger works. That is, while the standard double superheater form is found best for satisfactory working, for the handling of various oils in a manner that no single superheater form will do, and for the fullest duty that may be thrown upon it in a sizable works, yet in the smaller works, where the work is lighter, and the operation limited to a very few hours, the single superheater form is found to be sufficient. This enables also a low first cost—an important point to small companies. The generator is deep, allowing the use of gas house or oven coke, as well as of anthracite; a heavy fire brick lined flue connects it with the superheater. This vessel, so essential for a good quality of gas, has large fixing capacity; is liberally supplied with manholes, and while 18 ft. in height, yet easily went under the gas house roof by letting the top interpose between the tie rods.

The oil heater is located in the take-off pipe to the seal, the heat of the hot gas being used to vaporize the oil. In this way a much higher temperature and fuller vaporization is obtained than can be had by a steam jacket or coil heater. From the hydraulic seal or washer, the gas passes to the special water gas scrubber already mentioned, and thence on through the existing old coal gas pipes, relief holder, boxes and meter, to the main holder, etc., as described. Throughout the apparatus the careful design and quality of work of the United Gas Improvement Company is evident, and a feature of the apparatus noted is the unusually full outfit included; those items that often appear as extras, such as auxiliary machinery, iron floor and stairs, coal hoist and bucket, and even clock and fire tools, etc., apparently being part of the regular complement.




WORKS OF THE HANOVER GAS COMPANY, HANOVER, PA.

It may be observed that the above form of typical small water gas apparatus is purposely not equipped with reverse steam connections. While such have for

long been part of this company's form for larger sets, it is claimed by it that for small works simplicity should be preserved above all things; and while hot valves and reversed courses of the gas, etc., may, under other or especial conditions, be desirable, they certainly are not for an apparatus of the size here considered, not only showing no advantage in operation, but positively disadvantageous, in addition to the extra first cost.

Take it as a whole, the plant at Hanover is a typical one for small companies, and we doubt not but that the local company will speedily attain, as have other companies, the numerous benefits attending the modernizing of its works.—*Light, Heat and Power.*

## SOME ITALIAN "SURVIVALS"—A "LONG HOUSE" IN THE TIBER DELTA.

By ROBERT H. LAMBORN, Ph.D.

AROUND the Eternal City, within easy riding distance, one may study many surprising phases of civilization. Six miles northeastward across the Campagna from the Porto del Populo, in a secluded valley far from the beaten roads, on the lands of Prince Borghese, I found several families numbering twenty-six persons, living in caves with their shaggy white dogs. They subsisted by gathering wild chiccory for Roman salad eaters, and by begging for alms at the city gates. A furlong from this cave is a veritable cliff dwelling. A deep cavity in an almost perpendicular escarpment of tufa rock is reached by a zigzag path. Its entrance is closed by a swinging bundle of bush, and within, the irregular floor is divided by rough stone walls into pens resembling those in a Colorado cliff dweller's habitation. On the western slope of the Alban Hills I once dismounted to inspect a flour mill owned by the Cenci family, where the vertical shaft of a horizontal flutter-wheel carries the diminutive grinding stone and the water flowing from a historic Etruscan drainage tunnel shoots down a steep stone channel, and dashing out a sparkling shower, whirls the toy-like wheel with all the prettiness and childish carelessness of force expenditure that one may see in a New Mexican Indian corn mill. The shepherds on the broad domain of Prince Torlonia live in beehive-shaped *capanne*, built of brush and reeds almost as simple in construction as the dwelling reared by our Western beaver. Their rent they pay weekly by selling ewes' cheese, made over a fire kindled on the earthern floor close to the bunk in which the shepherds sleep.

On April 13, 1888, I rode by the Via Ostia, through the Tiber Valley, to the district where that river divides and enters the Mediterranean. I reached, not far from the sea, the property of Prince Aldobrandini and soon approached his country seat, near which arise four curious and conspicuous structures, in close proximity to the roadway. At first they seemed to be huge haystacks, the stored herbage of Tiber's fertile delta, but nearer inspection proved them to be houses. It was quickly evident, too, that they did not lack inhabitants, for a number of women and children flocked from an opening in the eastern end of the largest structure, and stood awaiting my approach. I was so strongly reminded of the "Long House" of the Onondaga Indians as given by Morgan (after Bartram) in his "House Life of the American Aborigines," that I handed my reins to a young man who had approached expectantly and entered the open doorway; men and women coming forward with alacrity to show me the interior economy.

I was told that this, with the three additional structures, were the dwellings of the laborers on the Aldobrandini estate, and that about 70 of the total population of about 250 found in this house their home. Its form is best shown by the accompanying sketches made in my note book on the spot. It is 110 feet long, about 26 feet wide, and is drawn to a comb about 40 feet above the ground. Vertical and horizontal poles form the framework, upon which are fastened osier walls, overlaid by flags and reeds gathered from the neighboring lagoons, thus producing a wind and rain proof covering. The storms and sunshine of years falling upon this thatch of water plants gradually change their color until the exterior is as black as a stack of clover hay. Only two openings, one at each end, admit you to this windowless house, and these are closed at night by heavy plank doors that are swung together and securely barred.

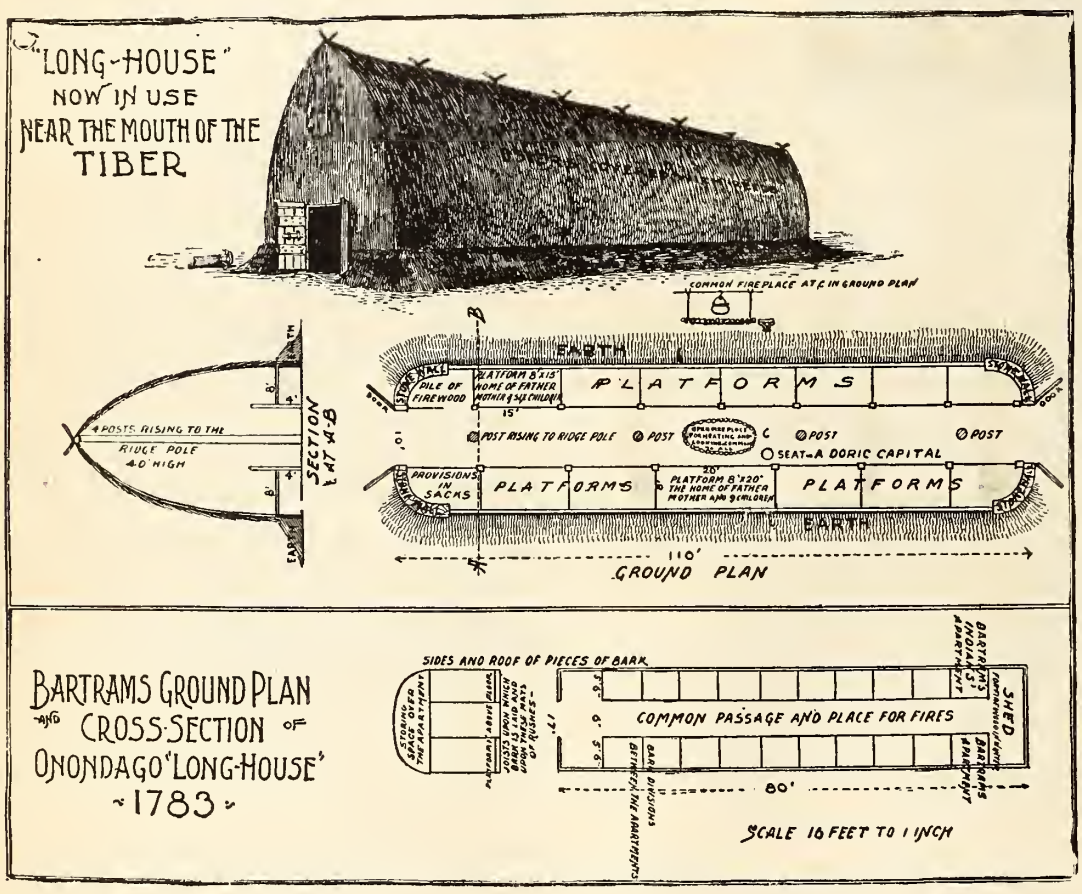
In the corner to the left was a pile of dry fagots, the common property of the community. This fuel is burned upon a hearth that occupies a central point upon the earthen floor. Over a smouldering fire on this hearth a brass kettle was simmering, and a wreath of smoke ascended into the gloomy, chimneyless upper spaces. On both sides of the middle passageway, and raised about four feet above it, was a long platform of rough plank. These platforms were divided by board partitions, about three feet high, into pens varying in length according to the number of persons intended to be accommodated, but averaging for each individual a floor space of about two feet by eight. Thus to one family of eleven persons was apportioned a pen twenty feet long by eight wide, which answered for them every purpose of a home; another, fifteen feet by eight, was occupied by a father, mother, and six children. These divisions held the boxes, clothing and sleeping arrangements of the family. In them children were playing mothers nursing, and several sick persons were lying wrapped in dark woolen blankets.

I see no reason to believe that this structure, and the method of living practiced therein, varies essentially from that which existed in the Maremma when Pliny possessed a villa near this spot, and when Cæsar drew his soldiers from among the forebears of these Roman peasants. We all know how slowly the habits of the lower classes change in old countries, and even residences in the most enlightened Italian districts show but little development since imperial times. Goethe relates that after visiting Pompeii with Tischbein, 1787, he entered a neighboring occupied dwelling which with its furniture seemed to him to resemble perfectly the habitations he had just studied in the mummied city, built more than twenty centuries ago. Indeed it is possible that this curious Aldobrandini dwelling is a survival closely imitating the form of house constructed by tribes that dwelt in this valley long before Rome was founded—when the Capitoline hill was a sheepfold in the prehistoric period of the Ausonian peninsula. This possibility is strengthened by the fact that all the materials for the house are of local production, are easy to transport and require only the simplest tools to assemble and erect, while the result is an enduring and excellent shelter. An additional and striking evidence of the aboriginal character of the structure is the close parallelism shown in the American "Long House" already mentioned, which was habitually built and inhabited by some of our best known savage tribes. For purposes of comparison I have reproduced here Bartram's sketch of the Onondaga "Long House," made on the occasion of his visit to attend a council of that tribe in 1743. It was 80 feet long and 17 feet wide. A common passage, in which the fires were built, ran between two sets of occupied apartments. These apartments were raised about a foot above the level of the passage on two platforms made of hewn saplings, that extended along both sides of the house.

They were formed by erecting bark partitions upon the platforms, and one division was allotted to each family. Soft pieces of dry bark and sleeping mats were spread upon the rough floor, and a fire for each four apartments kept the house warm and served for cooking. Above each fire a vent in the roof allowed the smoke to escape. Extending over the apartments was a sort of second story in which household effects could be deposited A corner in this dwelling was devoted to the common store of firewood.

"Long Houses," resembling the one pictured by Bartram, are transcribed by Greenbalge, who visited the village of the Iroquois-Senecas, near the present site of Rochester, in New York, in 1677. One was about 100 feet in length, made of a strong framework of poles set in the ground and covered with strips of elm bark tied to this frame with strings. The living apartments were arranged as described in the Onondaga house. Skins, forming curtains, hung over the entrances, and from the roof were suspended bunches of Indian corn ears with their husks braided, and festoons of bits of dried squashes and pumpkins strung upon long pieces of cord.

My visit to this cheerful community in the Tiber delta, I regret to say, was too brief to allow me to enter upon the study of its domestic economy. Valuable material for comparison with the Indian customs would be obtained by investigating how far the property and supplies, such as firewood and food, are procured and held in common, and what household habits had developed to increase the convenience and comfort of families crowded into a place so restricted. But my destination that day was further southward along the blue Mediterranean, to the beautiful Castle Fusiano, with its vast domain of towering pine trees, where for miles one may gallop over smooth roads made fragrant by myrtle and sweet daphne, with long level reaches where the shadows are as profound as those that darken the primeval forests of the Alleghanies.—*Science.*




## EDISON'S PHONOGRAPHIC LEVEE.

MR. EDISON held a levee recently in his laboratory at Orange, N. J. For the first time, he listened to the voices of European emperors, kings, statesmen, poets, artists, and of other potentates and potentialities who for years past have been addressing him through the medium of his European colleague, Col. George Edward Gouraud. These messages of congratulation, admiration, and declamation, intermingled with scraps of verse, snatches of song, and ripples of laughter, were at various times and in various places talked into phonographs belonging to Col. Gouraud, and then the cylinders were sealed and packed away till such a time as the colonel could visit "the Wizard" in his American home and personally hand the precious souvenirs to him. Of this opportunity Col. Gouraud has now availed himself. Transcripts of the messages had of course been sent to Mr. Edison by mail, but the actual voices he only heard recently, and of these voices not a few have now passed away to the Silent Land.

It was only a family party in the library of the laboratory. Mrs. Edison was present and so were two sons of Edison's first marriage—thoughtful-looking, well-dressed lads of 18 and 16—and Mrs. Marvin and Miss Miller, sisters of Mrs. Edison. Then there was a niece, a tall, pretty blonde, Miss Edith Edison, and a brother-in-law, "Freshman" Miller from Yale. Col. Gouraud was accompanied by his son, Fauvel Gouraud, by Mr. A. Graham, an English electrical inventor of some note, and by Mr. John Beaufoy Lane, a London journalist.

The unique treasure box of science was carefully unsealed in the presence of Mr. Edison, and then the row upon row of cylinders were revealed, duly labeled with the names of the owners of the voices that were concealed in their waxy circumferences.

The first voice placed on the phonograph was singularly appropriate to this Eastertide, and yet a solemn and touching beginning to an occasion which could not fail to evoke much varied feeling in the hearts of all of the little party present. It was the voice of the late Cardinal Manning, Archbishop of Westminster. Clearly yet softly came the words of the dead prince of the Roman Church:

"A hearty greeting to the inventor of the most wonderful instrument of modern science. Henry Edward, Cardinal-Archbishop. Easter Day, 1891."

After the cardinal came a few royalties, beginning with his majesty of Greece. This monarch over the realms of the classics has a powerful voice, and he spoke in Greek. It must have been rather indifferent Greek, as nobody understood him, but his signature, "Georgius," was very loud and impressive. In a general way he was understood to express his regret that the phonograph was not in vogue in the days of Homer. The present King, Queen, and Crown Prince of Italy followed. Their majesties and his royal highness talked in excellent English, barring their natural Italian accent, and all three briefly expressed eulogiums of Edison and his inventions. "A return of fairy days," said Queen Margaret, and Prime Minister Crispi grunted a few words of complimentary approval in French. King Umberto added that he hoped Edison would frequently wear the Italian order of knighthood he had sent him.

"It is in the glass case with the other medals," said Edison.

Next came words in a weird and most unknown tongue, yet musical in their intonation. They were revealed as the voice of one Burghast—or something of that sort—Effendi, a Persian poet in the suite of the Shah when that "King of Kings" last visited Europe. His "Imuensity" declined to speak himself, and so did the princes in his suite; but the poet was commanded to be equal to the occasion. He probably was, but his declamation to Mr. Edison seemed to weary the Wizard, who observed at the conclusion of Mr. Burghast's effort, "I've got as much sentiment about me as a locomotive." He listened, however, with an amused smile to the next voice, that of Mrs. Bancroft, the actress. She also recited a poem. "What We Do at the Springs," a lively skit on life at a German spa. Every verse terminated with a burst of laughter from the actress—the inimitable laugh that has convulsed thousands of audiences. Edison and family soon caught the infection; but it faded away while husband Bancroft recited something from "London Assurance."

Then came a group of military voices, beginning with the Duke of Cambridge and Gen. Lord Wolseley. They were mainly Christmas greetings and congratulations to Edison, spoken at a dinner specially given to Col. Gouraud to meet the royal commander-in-chief of the British army. Then came the Prince and Princess of Wales, spoken at Sandringham when Col. Gouraud was one of a house party which included the Empress Frederick and her daughters and the late Duke of Clarence. "I am delighted with this charming instrument," said the voice of the Princess of Wales. "Yes; most wonderful, most marvelous," rolled out the voice of the prince. Then came a word or two

from Lord Salisbury: "I can add nothing to that which their royal highnesses have just spoken."

THE GRAND OLD MAN SPEAKS.

England's greatest and grandest old man came next, and the face of Edison lit up with pleasure. The cylinder began by stating that Mr. Gladstone was present at one of the "Round table dinners" given by Mr. James Knowles, editor of the *Nineteenth Century*, at Queen Anne's Lodge, London. The company included Lords Aberdean, Meath, Playfair, and Rowton (Disraeli's secretary), Sir Morell McKenzie, and Sir John Fowler, the great engineer. Gladstone's voice was clear and sonorous. There was an absence of the broad "a," but a presence of a broad roll to all the "rs."

"I cheerfully comply," said he, "with the request you have done me the honor to make, but I regret to say that I can only send you the remnant of an organ that has been overstrained. As much of my voice as is left I gladly give you. Wonders upon wonders are opening up before us. Your great country is leading the way in the great work of invention, and to you, as one of its greatest celebrities, I send my hearty good wishes for all that pertains to the well-being of mankind. To Edison. WILLIAM EWART GLADSTONE."

Two dead but never-to-be-forgotten minstrels followed, Tennyson and Browning. The dead laureate began by exclaiming that he never could remember a line of his own poems, so he begged permission to read something into the phonograph. The "something" was his "Ode to Wellington," dated from "Aldworth" and signed "Alfred Tennyson."

Browning failed in memory like his brother poet, but he began by trying to remember. His recitation was his poem, "How they carried the news from Ghent to Aix." The cylinder recorded faithfully the pauses of the poet—it all was so uncanny, if lifelike—"Oh, I can't remember, I can't remember." Then he d continue for a space, then "hum" and "haw," then he broke down and laughed merrily, and finally the cylinder recorded cheers and hand clapping. A crowd of artists were surrounding the poet, and the applause was led by Sir Frederick Leighton.

Mr. Edison, however, was still thinking of Gladstone. "He," he suddenly exclaimed, pointing to the record of Gladstone's voice, "he is the most marvelous organism that has been produced by nineteen centuries. The evolutions of another 500 years, however, may make such men common," and the Wizard looked at Col. Gouraud, but that gallant warrior was not equal to a reply. However, the colonel turned on Gen. Boulanger, the voice of the deceased French celebrity being preceded by a few bars of the march written in his honor. "I always like to hear that," said the general, in French, and then he followed with some exquisite, if verbose, compliments, and signed himself (verbally, of course) "Ernest Georges Boulanger, General en retraite."

The cylinder was completed by a few words from the Duchess d'Uzes, the wealthy and high-born French woman who is supposed to have found the money for the Boulanger boom.

Lord Armstrong, maker of great guns, spoke next. Before speaking, at the time the record was taken his lordship examined every part of the phonograph and went on his knees to look closely at certain portions. It was suggested that he would fatigue himself, and the man of mighty sounding metal was equal to the moment. He at once spoke into the phonograph: "This is an instrument of science before which any man may well kneel." Edison smiled as it rolled out to him.

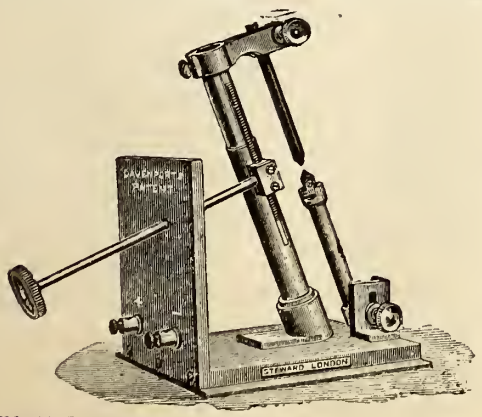
Then came Lord Kelvin (Sir William Thomson), President of the Royal Society, whom Edison regards as the head and front of scientific attainment of this century. In his Scotch dialect, his articulation bristling full of the Scotch burr, were the words, "Of all the marvels I have seen and heard, the thing that astonishes me the most is the hardihood Edison showed in attempting to do it."

Lord Rayleigh, Secretary of the Royal Society, and another of the great scientific lights, continued on the cylinder: "If Edison had known as much about the known laws of the science, he would have known that he couldn't do it"—which is a scientific epigram with a vengeance. It may be added, however, that Lord Rayleigh is the first living authority on the theory of sound, and the greatest ever living, excepting perhaps Helmholtz.

The voices of a number of minor lights in the worlds of everything concluded the seance, and before farewells were given it was agreed by Mr. Edison and Col. Gouraud that their libraries of voices should be amalgamated and left as a hereditary trust to the eldest representatives of the Edison-Gouraud families. Fauvel Gouraud, a yound intending lawyer, about to graduate at Yale, was told that he could draw up the necessary papers.—*N. Y. Sun.*

## ELECTRIC ARC LAMP FOR LANTERNS.

THE instrument is designed to overcome one of the obstacles to the use of electric light for magic lantern purposes, viz., that the users are often insufficiently acquainted with electrical processes to work the mechanism of an automatically-fed lamp to advantage.

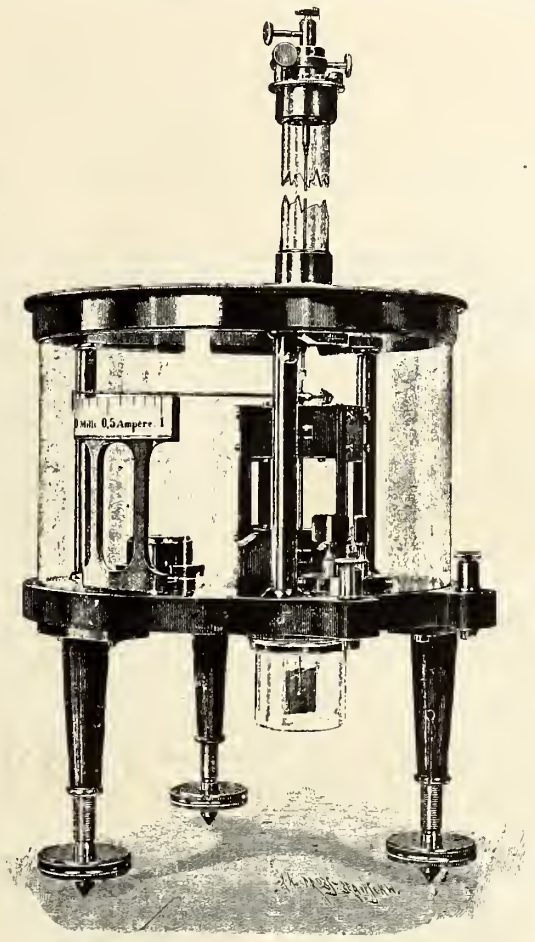



ELECTRIC ARC LAMP FOR LANTERNS.

Davenport's lamp is a hand-fed one, consisting of two carbon holders, the lower of which is automatically kept in position by a spring, while the upper one is moved forward periodically by the operator's hand working a rod at the back of the lamp attached to a rack-and-pinion arrangement. This rod requires readjusting at intervals of about five minutes. The lower tube can be readjusted at will. The lamp shown in our illustration sells at £4 4s., but it may be had with a special connection, which renders it impossible to connect up in the wrong manner, at 11s. extra. The lamp will fit any ordinary lantern, so that, in case of want of electric light power, the ordinary limelight may be used. It has been used at the Society of Arts and the Camera Club with much satisfaction, and with the extension of stations for the supply of electricity there can be no doubt that it has a considerable future. J. H. Steward, London, is the maker.

## A NEW ELECTRO-DYNAMOMETER.

SOME time ago an electro-dynamometer was constructed by J. W. Giltay on the well known principle of Bellatti. The instrument was very favorably received, but it was recognized that its usefulness might be greatly extended if it were capable of being standardized. Terrestrial magnetism exercised a very disturbing influence on this instrument, so that the reversion of a battery current flowing through it was attended with undesirable results. The difficulty has now been got rid of, and in a recent number of the *Annalen der Physik und Chemie* a new form of apparatus is carefully described.




A NEW ELECTRO-DYNAMOMETER.

The essential part of the instrument consists in two bundles of iron wire, in every respect similar to one another, which are suspended parallel to and above one another in similar coil frames. The turns of wire in the coils are similar in arrangement and equal in number. When a current is sent into the apparatus it circulates through both coils in opposite directions and magnetizes the iron bundles in such a way that they form an astatic system. In this manner the disturbance due to terrestrial magnetism is eliminated, and it becomes possible to standardize the instrument accurately.

In his paper Giltay describes with great minuteness the precautions which he observed in standardizing, and he makes use of the term "astasia" very frequently to denote the condition of the superimposed, parallel core bundles. There are also a number of tabulated results obtained from typical experiments illustrating the use of the instrument.

We may here observe that this paper is characteristic of that diffuseness which is so common in accounts of German research. In whatever else English scientists may fall short, they certainly do not, fortunately, err in this direction.

In the figure is shown a general view of this improved electro-dynamometer in a form which is specially designed for electro-therapeutic purposes. The index has a length of 11 cm.; it is marked by means of an aluminum needle. Each iron bundle consists of 116 wires of 0·3 mm. thickness and 18 cm. length. These are suspended by means of raw silk fibers situated 1·2 mm. apart. The index is parallel to them and makes, with the plane of the coils, an angle of 47°. Beneath the floor of the apparatus is a level and an ordinary plug commutator. When the two plugs are inserted in the proper holes the instrument is astatic, and is suitable for use with battery currents. When, on the other hand, the two plugs are placed in the other holes the instrument is ready for use with induction currents. Devices are inserted which make it impossible to injure the instrument by making wrong connections.

The theory of this electro-dynamometer is, of course, the same as that of Weber's electro-dynamometer.

The instrument illustrated was constructed for Dr. J. L. Hoorveg, at Delft. An account of it by him appears in a work entitled "Die Medicinische Electrotechnik und iten Physikalischen Grundlagen" (Leipzig, Engelmann), pp. 70, 129 and 130, where the methods of applying it in therapeutics are indicated and discussed.—*The Electrical Review.*

## ANOTHER EARLY TRANSFORMER WITH CLOSED MAGNETIC CIRCUIT.

By A. M. TANNER.

ANOTHER contribution to the early history of transformers, or inductoriums possessing closed magnetic circuits, is the British patent of Thomas Allan, dated June 24, 1852, No. 14,190. The specification of this patent states that "the first part of my invention consists of improvements in producing induced electric currents by means of electro-magnets, which currents are applicable to various useful purposes. For the purpose of thus producing induced electric currents I compose an electro-magnet, or combination of electro-magnets, of several straight pieces of soft iron, so as to form an electro-magnetic circle, and I prefer to

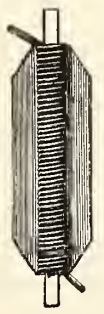


FIG. 1.

FIG. 2.

form such magnet or combination of four pieces, but it may be composed of three pieces, or of five or more such pieces. I cover these pieces with the primary coil of insulated wire and then place the secondary coil, also of insulated wire, around the primary coil, and the pieces being straight they may have the coils wound upon them in a lathe with great facility. The pieces, having had the coils put upon them, are then to be connected at their ends, so as to form, when electro-magnetized, a complete electro-magnetic circle.

"The wires of the primary coils are then to be connected together, so as to form one continuous primary coil, the two ends of which may be connected with a battery in the ordinary manner. The wires of the secondary coils around the pieces of the magnet or combination are also to be connected, so as to form one continuous secondary coil, the two ends of which are to be connected with the line wires of an electric telegraph apparatus, or with the wires of any other apparatus to which the same may be intended to be applied.

"In Figs. 1, 2 and 3 I have shown the mode of constructing an electro-magnet, or combination of electro-magnets, of this description with four straight pieces of soft iron.

"Fig. 1 shows a straight piece of iron with the primary coil wound upon it, the ends projecting a little beyond the coils.

"Fig. 2 shows the same straight piece of iron with the secondary coil also wound upon it, and the ends of each of the coils are left long and projecting so as to be ready to be connected with any other wires.

"Fig. 3 represents four straight pieces of iron with primary and secondary coils around them, as already described, and the pieces joined together at their ends by nuts, screws or other means, so as to form an electro-magnet. The primary coils around the pieces are also joined together so as to form one continuous primary coil, the ends, A and B, of which are shown projecting and ready to be connected with the poles of the galvanic battery, which may be intended to be

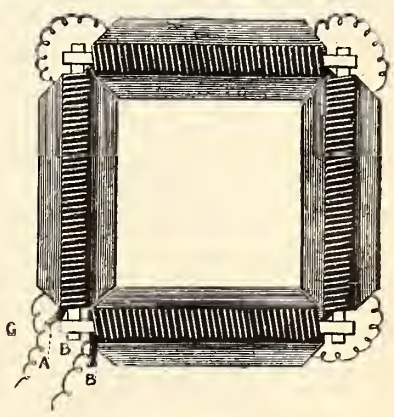



FIG. 3.

used. The secondary coils are also joined together in like manner, so as to form a continuous secondary coil, the ends, G and H, of which are shown projecting and ready to be connected with the wires of any apparatus to which the induced current of electricity may be intended to be applied."

The patent drawing relating to the transformer part of the invention is reproduced to illustrate the construction, which is very much like that of some modern transformers in which the primary and secondary coils are wound continuously in the same direction on the core sections. It will be seen that the description is silent as to the lamination of the core sections.—*The Electrical Review.*

TRACED BY FOLIAGE.—In tropical forests so large a proportion of the plants are of the sensitive variety that sometimes that path of a traveler may be traced by the wilted foliage.

[Continued from SUPPLEMENT, No. 955, page 15261.]

## WATER TUBE BOILERS.*

IN this, the last of our series of articles on water tube boilers, we propose to consider the principles which should guide those who wisb to design express boilers of minimum weight. The future demand for such steam generators will probably be large. Their use will, it is true, be almost wholly confined to ships or torpedo boats; but tbe growing demand for higher and higher speed, which can only be obtained by reducing the weight of the machinery employed to produce it, cannot fail to stimulate invention; and we do not, at this moment, know of any department of mechanical construction which holds out so many chances of reward to tbe inventor as the production of really excellent express boilers.

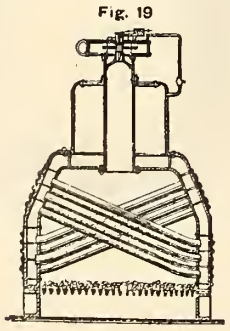
In a previous article we have pointed out that if a boiler is to be as light as it can be for the power, it must have no waste surface. We prefer the word "surface" to "material," because the former includes the latter, but the latter does not necessarily include the former. Surface represents weight. A boiler with very small surface might have very small weight, but its power would be small. The conditions of the problem, to the solution of which we desire to guide our readers, are that tbe greatest possible amount of surface shall be had with the minimum weight. By surface it is always to be understood that we mean useful surface; either surface employed in generating steam or holding it when made. It can be shown that in every boiler, or, more strictly speaking, in every plant, apparatus, or contrivance for the generation of steam, a certain proportion of the surface must be useless as far as the making of steam or the holding of it when made is concerned. To every boiler as to every bucket there is an inside and an outside. No more of the outside can be used for making steam than tbe area in contact with water inside. Heat may be applied with some advantage, however, to the surfaces in contact with steam to prevent adverse radiation, and keep the steam dry and hot. We find that in some boilers tbe whole outer surface is useless for steam making or heating. In others it is all utilized, and yet the waste surface is not minimized. For example, no portion of the outside of a locomotive boiler is heated. In fact, so far as steam making is concerned, the whole of the heavy shell, representing a weight of some tons, is of no account. In the case of Lancashire boilers the whole outside of the boiler isheated, steam space and all. But even then the whole surface of the apparatus is not used, because the insides of the flues, and of the brick setting generally, cannot make steam, and so far represent useless weight.

It is necessary to insist on tbis point, because, in not a few ostensibly express boilers, the weight of the useless surface is much too great to allow the boiler to succeed. At the same time there must always, and under all circumstances, be *some* useless surface, and the inventor or designer should endeavor to make this as small and as light as possible.

We have next to consider what our heating surface shall weigh. As a base line we may take its minimum weight as 5 pounds per square foot. That means soft steel, ⅛ inch thick, disposed in tubes 1 inch in diameter inside; such tubes may, if nearly vertical, have a length of 100 diameters—that is, each may be 8 feet 4 inches long. Greater lengths are not prohibited. The proportion we give it is perfectly safe to adopt. But a boiler cannot be made up of small tubes, unless indeed it is of the type described in our fourth paper, and has forced circulation; and it is on the way that the tubes are combined with other portions of the boiler that the final weight of the structure will depend. Provision must be made for the downflow of water, as well as for the uprise of steam, and of water driven up by the steam. There must be a steam collector, and a furnace or place wberein the grate is to be placed. Now there are three systems of combination, all in favor with different inventors. We have first the system very fairly represented by Fig. 19. Here we have flat-stayed surfaces composing a fire box. From the water spaces thus made originate inclined water tubes. Above all is placed a water heater for utilizing the waste gases. Secondly, we have the Thornycroft system, in which the sides of the furnace are made up of small water tubes springing from large tubes; and thirdly, we have the Yarrow system, in which the fundamental principle of construction is the same as the Thornycroft.

Now it can be shown in a moment that Fig. 19 cannot

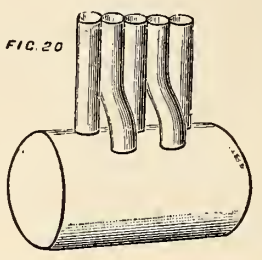
Fig. 19



give us the lightest possible boiler. It would not be safe to make the sides of the chambers less than ¼ in. thick and they must be stayed with ¾ in. stays spaced 4 in. apart. A water space of at least 1 in must be allowed between the plates, and opposite every tube end must be a screwed plug. The stays limit the number of tubes that can be used very seriously; but leaving this consideration on one side, we find that a square foot of heating surface in the sides cannot weigh less than 24 lb., the useless outer plate being, of course, included, and this allows nothing for the "making up" of the ends, top, and bottom of the flat chambers. It may be taken as proved that the lightest sides that can be used for a fire box are made of tubes. But if we use tubes only, what are we to do for an inclosure to keep the products of combustion in and cold air out? The boiler shown in Fig. 19 needs very little of this, because it is, so to speak, self-contained. In the Yarrow boiler the products of combustion pass outward directly to a space between the outer tubes and tbe side doors, or smoke box doors, as we may call them.

In tbe Thornycroft boiler the lower or furnace portion of the boiler is made self-contained by bringing the tubes of two rows into contact, which is done as shown in Fig. 20. In the outer row of all, the tubes are

FIG. 20



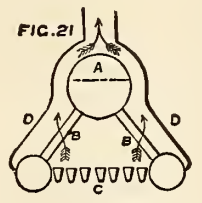
bent at the lower ends, so that, while sufficient space is left between the holes in which the tubes are set, the outer tubes are brought in to stand in the spaces between the tubes in the next inner row. In this way is built up a side sufficiently furnace gas tight for all practical purposes, and yet weighing only 10 lb. per square foot; we say 10 lb. because the outer surfaces of the tubes are of no steam making value, but none the less do they weigh 5 lb. per foot.

Turning to the steam drum and water legs, it will not be safe to make these less than ⅜ in. thick, and they are of no value at all, or of but doubtful value as steam makers in any part of them. But it is clear that, being cylindrical, and having a considerable surface available for fixing tubes in, they are about the lightest possible structures that can be provided for the purpose. But, nevertheless, there are opportunities for saving weight afforded in the matter of flanges, manholes, covers, and connections. The express boiler ought to bave no flat surfaces. A flat surface cannot be made so strong to resist pressure as a cylindrical surface, weights being the same.

But when we have settled this point, another arrives for consideration, namely, the weight of water in the boiler. Let us assume that we want 1,000 ft. of heating surface, which should give with very great ease 500 indicated horse power. Let us suppose that every foot of surface is covered by 1 in. of water; we have then 144,000 in. of water, weighing 5,187 lb., or about 2⅓ tons. The heating surface at 5 lb. per foot will only weigh 5,000 lb. These figures will suffice to bring home to our readers that in express boilers the weight of the water is a very important item. We have here, for boiler and water togetber, a minimum weight of say 4½ tons as the least conceivable—not by any means the least possible—for the water legs and steam and water drum have to be added, and these will not only weigh a good deal, but will hold much water. The water legs must have enough diameter to allow the tube roller to be used as we have already described; and it may even be found worth while to put into each a second empty tube, to act as a displacer, and so save the weight of so much water. A tube 10 ft. long and 10 in. in diameter will itself weigh between 600 lb. and 700 lb., and it will hold over 700 lb. of water. It is easy to see how rapidly weight mounts up.

But we have not yet done. Let us suppose that our tubes are all disposed in the simplest possible way, as in Fig. 21. Here we have the steam drum, A, the

FIG. 21




evaporating tubes, B B, the grate, C, and the outer covering, D, taking the smoke to the chimney above. This is all very well, but the ends of the boiler, or rather of the furnace, have to be made up. How, and with what? If we use fire brick, it is clear that we have to put in gable ends, so to speak, of that material, and as these must be thick—for tbey are exposed to a furious assault from the furnace—and will have to be set in some kind of iron frame, they will be very heavy. For this reason some few inventors have proposed to make the ends up with heating surface, which, if not lighter than the brickwork, would at all events be of use. One scbeme is to place at the back end a tube of the shape shown in Fig. 22. In this, A A are the two

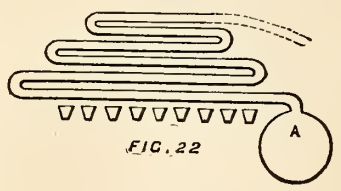



FIG. 22

water legs. The pipe is of copper and used to take the feed water into the boiler. The dotted line goes to tbe feed pump. There are grave objections to this scheme, which we need not stop to discuss. Again, the outer casing, D, is common to all express boilers, although it may assume different forms and proportions. It cannot be made to weigh less than 5 lb. per square foot, and may weigh a great deal more. It represents an important item, and it is well that it should be kept as small as possible.

It is, of course, impossible within reasonable limits to touch on any but a few of the host of questions which start up in the face of the engineer who sets about designing an express boiler. The problem in its broadest and most recent form takes something like this shape: Given a space 8 ft. long, 6 ft. wide, 8 ft. high, get into this the maximum amount of power, the total weight of boiler with fire bars, water, and fittings, not to exceed 3 tons. Of course, the dimensions available and the weight permissible vary with the purposes to which the boiler is to be put. It may be of small power or it may be of large, one of a number or isolated. We have, we tbink, said enough to give a general notion of the way in which the design must be attacked. Thus, for example, we have probably made it clear that flat-sided water spaces cannot be used. All the surfaces must be cylindrical, except a few, which are best made dished; and tbe tubes ought to be of small diameter, because the weight of water varies inversely as the square of the diameter, while the heating surface varies only as the diameter. It is perhaps worth adding the caution that express boilers can only be worked with *pure distilled water quite free from grease*. The notion that tubes can be kept free of scale by the current of water is entirely erroneous; the process of scaling up is only delayed. The scaling is not prevented.

The following tables of coefficients or multipliers may be found useful:

| Diameter of tube in inches. | Coefficient. |
|---|---|
| 1·0 | 0·2631 |
| 1·5 | 0·3926 |
| 1 75 | 0·4580 |
| 2·0 | 0·5234 |
| 2·25 | 0·5888 |
| 2·5 | 0·6543 |
| 2·75 | 0·7197 |
| 3·0 | 0·7854 |

To use it, multiply the length in feet of the tube of the given diameter by the coefficient. The product is the surface of the tube in square feet.

Finally, it will be seen that we offer no advice as to the best method of arranging the heating surface. That is a matter which every inventor will settle for himself. Indeed, it may be said that it forms the basis of nearly all the patents now being taken out for water tube boilers. In our own opinion the system adopted by Messrs. McBride and Fisher embodies about the best principle that can be used. The products of combustion pass among the tubes, first nearly at right angles to them in the lower part of the boiler, and then go on more or less parallel to them above the fire tile division deck to the chimney. In this boiler the sides of the fire box have to be made up with a fire tile casing, which stands for the gable ends of the Thornycroft and Yarrow boilers, and it would be improved by at least partially filling up the space with tubes rolled into the horizontal water legs at each side.

In conclusion, we would impress on our readers the importance of providing for the delivery of dry steam. No matter how satisfactory in other respects an express boiler may be, if it sends wet steam to the engines, it must be more or less nearly worthless.

## BOILERS FOR TORPEDO CATCHERS.

IN the course of the series of articles which has recently appeared in our pages on water tube boilers, we defined an express boiler as one which, while very small and light, would produce a great quantity of steam. In other words, an express boiler is a generator wbich weighs very little and occupies a small space as compared with normal or well known boilers. The express boiler—using the words in their full significance—is a recent or latter day creation, rendered possible only by the use of distilled water. We have dealt with the subject as though an express boiler must of necessity be a water tube boiler; but it is not certain that this is an invariable rule. Many years ago an exceedingly ingenious boiler was made and patented, we think by Hancock, for use in a steam road carriage. It consisted of flat sheets of metal on which were stamped hemispheres or circular protuberances. These, when the chambers were built up in a frame, abutted against each other, and prevented the chambers from opening when pressure was exerted inside them; the hot gases passed up between the chambers. This boiler was very light and very efficient, and it is quite possible that the idea might be developed in the present day with advantage. Be this as it may, we have no reason to doubt tbat while a very light boiler may be made not necessarily wholly composed of tubes, the lightest possible boiler must be made of tubes and of nothing else.

It is commonly taken in the present day that, if one indicated horse power can be got out of two square feet of boiler heating surface, the result is very satisfactory. This means an evaporation of about 10 lb. of water per square foot of surface per hour. If it were possible to double this, and get an evaporation of 20 lb. per square foot per hour, the advantage would be so great that it is worth while to do much scheming, and inventing, and experimenting to reach the required end. But it must not be forgotten that in no boiler can all the surface be heating surface; and we might have a boiler which was very efficient in one sense and very heavy in another, because the heating surface bore a comparatively small relation to the whole quantity of metal in the boiler. Thus, for example, a large so-called locomotive boiler—a true locomotive boiler has never yet been tri d at sea—weighing under steam 13½ tons, will make steam for a triple expansion engine indicating 800 horse power. This gives nearly 38 lb. per horse power. Two square feet of heating surface in tubes would only weigh 20 lb., allowing one-half their surface to be inefficient. It is easy to see that the best result cannot be got out of a locomotive boiler. There is far too much flat surface to be stayed. About the maximum performance for this type has been got, we think, by a Thornycroft boiler, which evaporated 10,840 lb. of water per hour. The total heating surface was 620 square feet; 78 lb. of coal were burnt per square foot of grate. But the air pressure in the stokehold reached 6 in. of water. The evaporation per square foot of heating surface was very nearly 17·5 lb. The total weight of the boiler without fire bars could not have been much short of five tons. Taking the power as 500 horses, we have 22·4 lb. of boiler per horse power. This does not include fire bars or other adjuncts, and the work is too severe to be long continued in that spe-

* From the *Engineer*, London.

cial type of boiler. Reverting, then, to tube surface, we have to consider how it shall be used. The first essential is that both sides—in other words, the whole surface—of each tube shall be fully heated, and not one side only. The next is that care shall be taken that an ample supply of water shall invariably be provided to take up the heat. If we have a long tube of small diameter, say an inch, and a very fierce heat, so much steam may be made in the bottom of the tube that all the water above will be blown clean out of it. Then water will rush in from below or above to fill the space, and this in turn will be ejected. We could name more than one water tube boiler which behaved in this way when hard pressed. The makers called the action "circulation," but it was not circulation in the legitimate sense of the term; a boiler worked in this way will soon be burned out and cannot fail to prime heavily. This "gulping" action is exceedingly injurious, and to be strenuously avoided. Bearing in mind the stipulation that the whole surface of each tube shall be heated, it will be seen at once that it is expedient that the tubes should be short. It is also evident that they must either be vertical or very steeply inclined. Any approach to the horizontal will result in disaster unless the tubes be very short and at least 2 in. in diameter. It may be taken as a rule that the fiercer the heat, the more closely should the tube approach the vertical.

Experiment goes to show that so long as a tube is made of metal not too thick, and abundantly supplied with water, it is quite impossible to burn it. We have already in a former impression cited Mr. Maxim's expeperiments in this direction. Years before Mr. Maxim thought about flying machines, Mr. Pope carried out experiments with tubes made of common tin plate soft soldered. These were buried in a blacksmith's fire, and everything possible was done to destroy them, but fire capable of putting a welding heat on a 3 in. bar could not melt the soft solder on the tube. We may take it for granted, then, that we cannot produce too hot a furnace. In this direction, no doubt, torpedo boat builders have proceeded a long way, and when 70 lb. or 80 lb. of coal are burned per square foot of grate per hour the temperature is very high. But something still higher can probably be got with petroleum. The maximum temperature to be had with proper arrangements and oil fuel will probably suffice to melt fire bricks of good quality much like sealing wax. If, now, there is practically no limit to the rate at which water will take up heat, it seems to be not at all improbable that an evaporation of 20 lb. or 25 lb. of water per square foot can be had. The notion that the water will be driven away from the tube surface and assume the spheroidal condition has no foundation in fact. But very great care must be taken to prevent the clinging of steam to the surfaces. An evaporation so rapid means, as far as the tubes go, only 5 lb. of boiler, and allowing 5 lb. more for the rest of the boiler, and other 5 lb. for water, we have 15 lb. per horse power, or for 800 horse power 12,000 lb., or say 5 5 tons, instead of 13 5 tons; and allowing a ton for fire bars and funnel, we still have a boiler which gives us 100 to 120 horse power for considerably less than a ton. That such a boiler can be produced we have no doubt. That it has yet been made we doubt, although results of trials made in the United States seem to show that engineers have got within measurable distance of it at the other side of the water, and on a comparatively small scale. The boiler of the Yankee Doodle is said to have 300 square feet of surface, and to weigh only one ton under steam. Fig. 14 *ante* illustrates it. It will be seen that we have made a tolerably liberal allowance of steam per horse per hour, and certain very excellent performances accomplished in this country are more to the credit of the engine than the boiler—a fact not to be forgotten.

If our readers will examine the designs of any express boiler, or will set about scheming one themselves, they will quickly find that there is a great deal of surface—in other words, a great deal of steel plate—that is of no use for generating steam. Not only does this weigh, but it takes up room which can ill be spared. Let us suppose that we use vertical tubes 3 ft. long; under them come the feeders, say 1 ft. in diameter, and above them the receiver, say 2 ft. in diameter. As the feeders must be below the grate level, there is less than 3 ft. left between the grate and the bottom of the receiver, and even then the whole boiler is at least 6 ft. high. The steam receiver and separator over the fire is the great offender. If it could be suppressed or put in another position, considerable advantage would be gained as regards height. It is held, of course, that it is essential in order to get dry steam. If it satisfied this condition, and if nothing else would satisfy it, then we must perforce have it. But it may be shown that the horizontal cylinder of considerable diameter, lying along the top of the boiler, is not necessarily the only expedient by which dry steam may be got, and that, in point of fact, unaided it will not give dry steam at all. There are various ways in which steam may be dried without the use of an unwieldy and heavy cylinder holding a great deal of water. It is true that each steaming tube must deliver a very large quantity of water mixed with steam. The steam can scarcely fail to fill the whole diameter of a 1 in. tube, and in any case its upward rush will entrain much water. If the tubes deliver against a flat plate, the concussion will knock much of the water out of the steam, and various devices are available for getting rid of the remainder.

It must not be forgotten that all we have just written applies to a very special and peculiar type of generator, in which a great deal is sacrificed for the sake of getting the largest possible quantity of steam out of the smallest and lightest possible boiler, and it is not to be expected that such a boiler can compare in economical efficiency with others. If we took an ordinary railway locomotive boiler and cut most of the barrel and tubes off, we should have a very efficient generator left, but it would not be very economical. Let us suppose, for example, that we burned 80 lb. of coal per square foot per hour in the grate; that the boiler tubes were 12 ft. long; and that a certain weight of water was evaporated per hour. If, now, we cut away all the barrel, save enough to leave tubes 2 ft. long, then the evaporation would still be nearly 75 per cent. as great as before. There would be a loss in economy of fuel, but there would be an immense saving effected in weight and in space. Furthermore, the reduction in the length of the tubes would permit us to reduce their diameter, and the economy and efficiency of the boiler would both be helped by that alteration. There is, indeed, no reason to suppose that an express boiler must be dreadfully uneconomical; but, on the other hand, any attempt to make it thoroughly economical will end in failure, unless indeed it is intended to use the boiler only for very short periods, in which case the spaces for the discharge of the products of combustion may be made contracted, but only by incurring the risks of sooting them up and ruining the draught.

There are, we have no hesitation in saying, possibilities in view which, made use of properly, will give us boilers of hitherto unrealized lightness and smallness. The principles to be observed are very simply stated. The first is that the heating surface, and indeed the whole boiler, shall be as far as possible tubular. The second is that every inch of surface not used for generating or drying steam shall be regarded as waste. The third is that great care should be taken to secure a regular discharge of steam from the heating surface. If the steam has any chance of hanging or clinging to the metal, disaster will follow. When we come to work with enormous temperatures, there is no time for the correction of an error. If, for instance, a tube should boil itself dry, in less than five seconds it would be white hot and would burst. Fourthly, special arrangements must be made for getting the water out of the steam. To comply with all the requisite conditions is very far from being a simple matter. So much has been done, however, that more can no doubt be done, and we do not despair of seeing a boiler which, complete, shall only weigh about 15 lb. per horse power, and nevertheless shall be sufficiently durable to satisfy all legitimate demands that can be made on a torpedo catcher.—*The Engineer.*

## CALICO PRINTING MACHINERY.

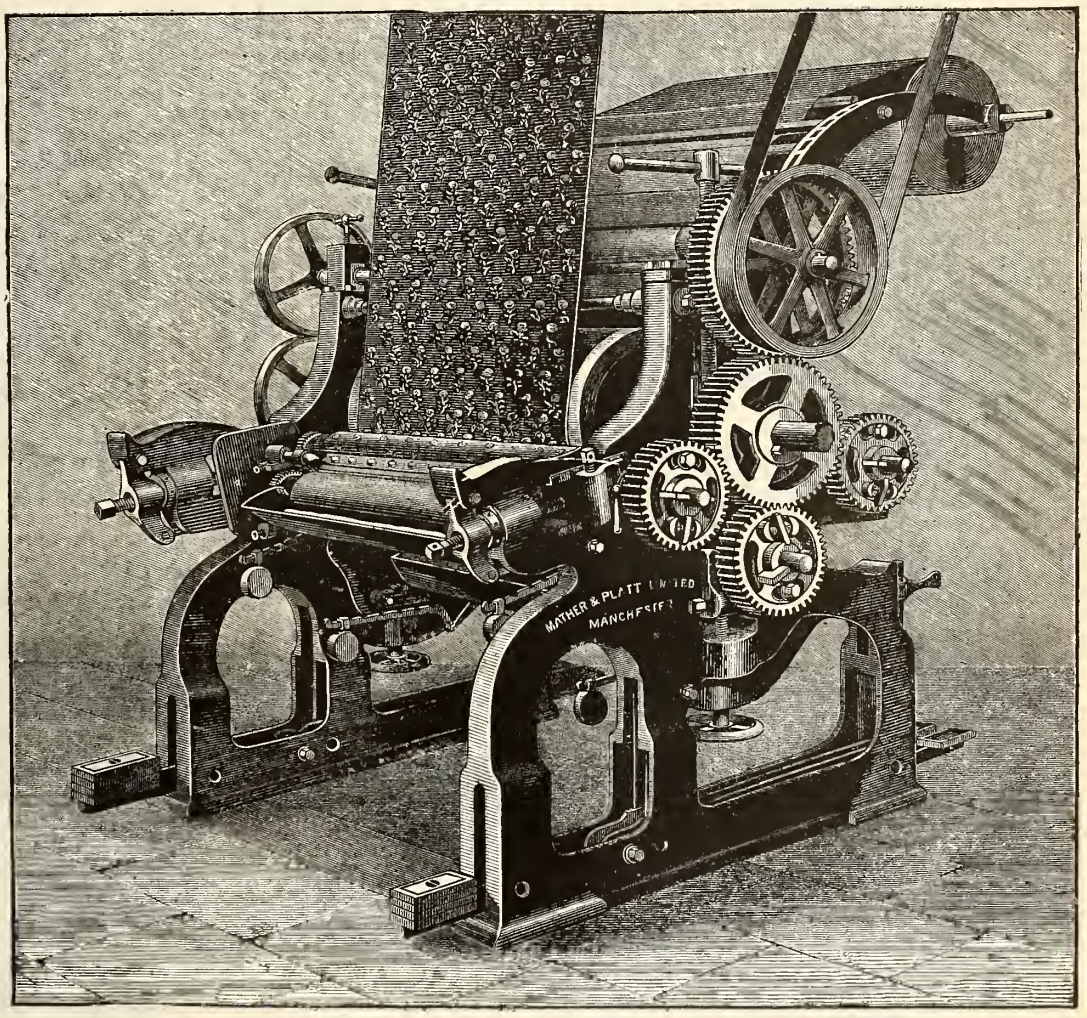
By John Waterson.

Although the two cylinder vertical engine is the one which is the most popular for driving the calico printing machine, the three cylinder engine appears to be regarded as the best for this purpose. The general appearance and arrangement of the printing machine can be seen from the extremely good illustration, representing Mather & Platt's three color machine. In any printing machine the frame should be strong and massive, in order to stand the great pressure put upon it without springing, and it should be well bolted to an absolutely firm and unyielding foundation. The side blocks, holding the bearings of the printing rollers, should be long, and plenty of adjustment allowed in all the moving parts.

Every part of the machine should be thoroughly well made and finished and the fitting accurate. As the pressure on the bearings of the rollers is heavy, they must be kept well lubricated—tallow, or tallow mixed with finely powdered plumbago, being the best lubricator. When the bearing becomes too warm it is a very common practice to hang a continuous loop of cloth on the end of the roller that projects out, and immerse the lower end of the loop in a vessel of cold water. The revolving roller turns the continuous band of cloth and thus a fresh part, impregnated with cold water, is constantly brought into contact with the heated roller; hence the bearing is kept much cooler.

The color boxes are supported underneath the printing roller on wooden or iron stands, which can be raised or lowered by screws. When the box is put in the machine the support is dropped, the color box put in and adjusted to exact position by means of the regulating screws. The furnisher is held in brass or gun metal bearings, fixed on the ends of the color box, and is driven by means of a toothed wheel, gearing into a similar wheel fixed on the end of the mandrel carrying the engraved copper roller. Thus it works generally at the same speed, or in some cases faster than the printing roller; many people are of the opinion that the furnishing roller should run about one-third slower than the printing roller. When it is required that the furnisher should travel in the opposite direction to that in which the pattern roller is going, a small toothed wheel, called a stud or stud wheel, is placed between the wheels on the ends of the furnisher and the print mandrel. This is nearly always done when printing colors contain large quantities of solid matter in suspension, such as all the pigment colors, and several other colors, that are liable to "stick in the engraving"—very often because it has not been there at all.

The engraved copper roller or shell is forced on to a wrought iron mandrel, which fits the bearings on the printing machine. The mandrel has a projecting tongue or "tab" which runs from one end to the other, and it fits a corresponding groove in the printing roller; thus the latter is prevented from turning on the mandrel.—*The Dyer and Calico Printer.*




THREE CYLINDER CALICO PRINTING MACHINE.

## THE SWORD OF ETHAN ALLEN.

By John R. Weathers, Washington, D. C.

Those interested in the early events of our country, and especially those who are thrilled with patriotic emotion at the stories of valor and devotion found in the history of the American revolution, will be pleased, I am sure, to know that the old sword of Colonel Ethan Allen is still preserved. The writer saw it recently in the National Museum, of this city.

The sword is an old-fashioned blade about twenty-seven inches in length and slightly curved. The handle is made of horn or bone, and is some seven inches long, making the total length, from tip to tip, about thirty-four inches. The mounting is of silver, marked with gold, but the latter is partially worn off. A dog's head of silver forms the end of the handle, and from this to the guard runs a silver chain. On one of the silver bands of the venerable leathern scabbard is the name "Ethan Allen" engrossed in large letters; on another band, "E. Brasher, Maker, N. York"; while on a third band appears the name "Martin Vosburg, 1775." What connection this last name has with the sword, no one seems to know.

Colonel Ethan Allen, the original owner of this sword, and whose fame has made it valuable and renowned, was born in Litchfield, Conn., January 10, 1737. He was active, patriotic and brave, and hated tyranny. Soon after the noted battle of Lexington, Mass., in the American revolution, Ethan Allen was requested by the General Assembly of Connecticut to enlist men and capture Ticonderoga, a strong fort in the State of New York, then held by British troops. He immediately raised 230 "Green Mountain Boys," and with them took the fort, in the early morning of May 10, 1775.

In describing the assault, and the part the illustrious sword played in the capture, it is, perhaps, best to quote from Colonel Allen's memoir.

"At the time of the assault," says the colonel, "a British sentry made a pass at one of the American officers with his bayonet, and slightly wounded him. My first thought was to kill him with my sword; but in an

instant, I altered the design and fury of the blow to a slight cut on the side of the head, upon which he dropped his gun and asked for quarter. This I readily granted him and demanded of him the place where the commanding officer kept. The sentry showed the way. The British commander asked me by what authority I demanded the surrender of the fort. I answered him, 'In the name of the Great Jehovah and the Continental Congress!' The authority of Congress," continues the colonel, "being very little known at that time, he began to speak again, but I interrupted him, and with my drawn sword over his head, I again demanded the immediate surrender of that garrison; with which he then complied."

The fort, the garrison, and about one hundred pieces of cannon were the result of this easy victory.

Colonel Allen died in Burlington, Vt., February 13, 1789, at the age of fifty years, leaving his sword to his son, Captain Hannibal M. Allen. At the death of Captain Allen, the famous blade was retained by his widow, Agnes B. Allen, who became a member of the family of her sister, Mrs. Benjamin Hopkins. But upon the marriage of her favorite nephew, Hannibal Allen Hopkins, she made her home with him for the last twelve years of her life. At her death, in 1863, the sword became the property of Hannibal Allen Hopkins; who, dying in 1871, left it, in turn, to his widow. This widow died a few years ago at Lansing, Mich., and the coveted sword passed into the hands of her son, Hannibal Allen Hopkins, Jr., through whose courtesy it has been loaned to the United States government and placed beneath a beautiful case in the National Museum, of this city.

This precious relic is a silent reminder of the great struggle through which our forefathers passed, for the overthrow of political tyranny and the establishment of a home for freedom and untrammeled intelligence.—*Education.*

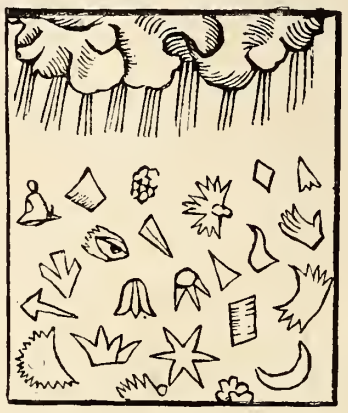
## STUDY OF SNOW CRYSTALS.

By Prof. Dr. G. HELLMANN.

(Translated for the SCIENTIFIC AMERICAN.)

IN ancient and mediæval writings we find the form of the snow seldom mentioned. It was quite natural that little attention was given to snow figures in ancient times, for the people of culture, who lived around the Mediterranean Sea, had rarely an opportunity of observing them. As might be expected, the earliest observations upon snow crystals were made by the people of northern Europe.

Albertus Magnus was probably the first one to call attention to the star-shaped form of the snow. The celebrated work of the learned Archbishop of Upsala, Olaus Magnus, which appeared at Rome in the year 1555, under the title of "Historia de Gentibus Septentrionalibus," contained a chapter on snow crystals, and likewise the first delineations made of them. On account of the great interest attending this first attempt to produce representations of snow crystals, a fac-simile is given. The author remarks in the text that the nearer one approaches the north pole, the greater is the abundance of snow figures. In one



OLAUS MAGNUS, 1555.

day fifteen, twenty, or even more different forms may be observed.

He attempted to point out these varieties plainly in his drawings, but he undoubtedly allowed much play to his imagination, for hardly any of the figures correspond with those forms which actually appear in nature.

Although Olaus Magnus first called attention to and delineated the variety of snow figures, he overlooked the hexagonal form, which lies at the foundation.

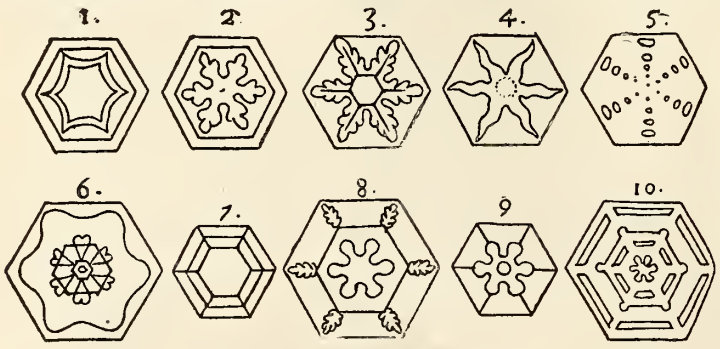
Kepler published, in the year 1611, the first book on snow crystals, "Strena seu de Nive Sexangula." Its purpose consisted not so much in describing new forms of snow crystals as to call attention to their hexagonal form. "Cur autem sexangula?" asks Kepler. He sought to establish various hypotheses which could not be maintained, assumed for each substance a peculiar forming or shaping power, and left the real solution of the problem to the chemist, who should say whether any salt or what kind was contained in snow.

The French scholar, Fabri de Peiresc, expressed his opinion, in the year 1623, that snow originated from seed, as plants.

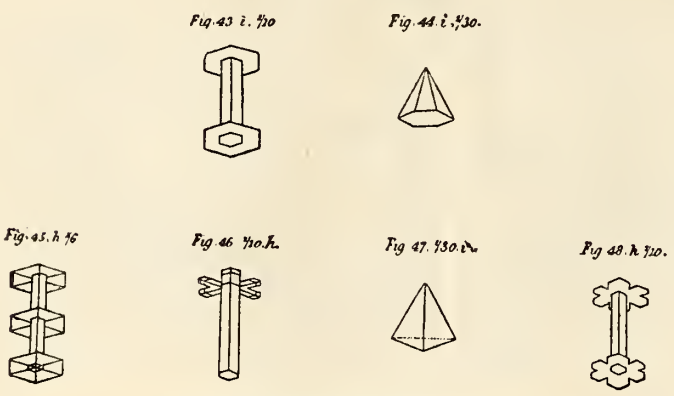
The observations upon snow figures published by Descartes, in the year 1637, show a slight advance.

The Danish mathematician and physicist, Erasmus Bartholinus, published in 1660 "De Figura Nivis," which contained drawings of snow crystals. For the first time somewhat complicated forms are represented. Bartholinus certainly erred in his drawings, as he failed to draw the secondary rays parallel to the principal rays. We are not informed whether this scholar used optical help in his observations.

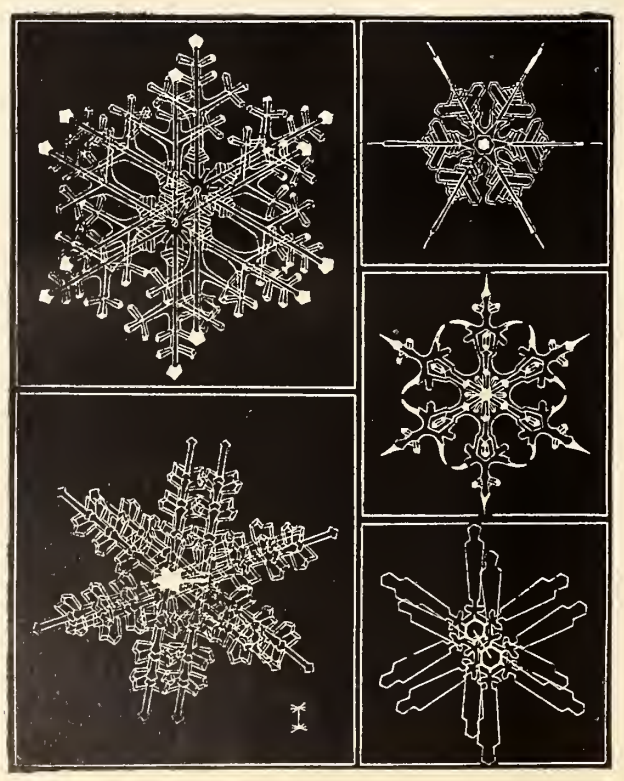
The English physicist, Robert Hooke, was the first to investigate the structure of ice, hail, and snow, by means of the microscope. His famous work, "Micrographia," contains a selection from more than a hundred forms observed by him. He has happily avoided the error in drawing of Bartholinus, for the conformity to law was known to him ("the branchings from each side of the stems were parallel to the next stem on that side"). In the year 1675 we obtain for the first time information in regard to snow crystals in the Arctic regions, through the German traveler Friederich Martens, of



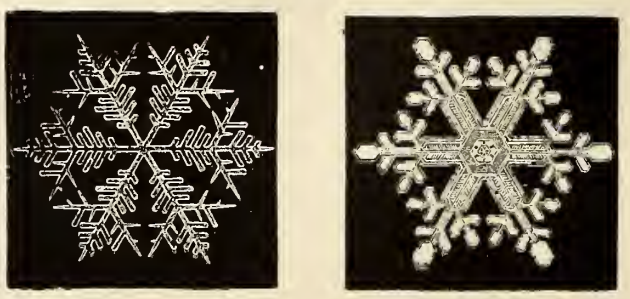

D. ROSSETTI, 1681.

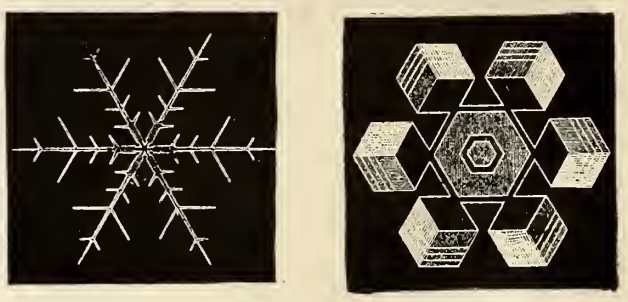



W. SCORESBY, 1820.



DRAWINGS BY J. GLAISHER, 1855.





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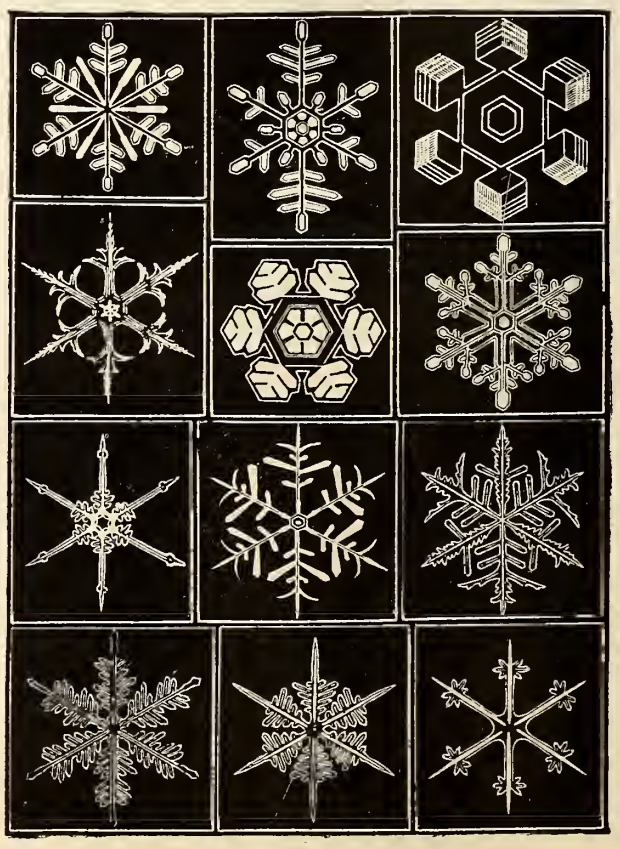


DRAWINGS BY J. GLAISHER, 1855.

Hamburg, whose great service in the exploration of Greenland and Spitzbergen is little known even in his own country. His delineations of snow figures lay more claim to our interest because he leads us step by step in the progress of tbe formation of the snow crystals, and accurately notices the state of the atmosphere in which they make their appearance.

The next important research leads us from the north of Europe to southern Europe, upper Italy. Donato Rossetti, a canon of Livorno, had, during his residence of six years as mathematician at the court of Turin, made a close study of snow crystals. He published his researches in 1681. The book seems to have been forgotten, yet it deserves our attention, for it contains an excellent collection of drawings of small, plate-shaped crystals, and the first attempt at a systematic classification of them into various types. Rossetti divided these crystals into five distinct classes: Bruscolo (blade of straw), Fiocco (flakes), Punto (points), Rosetta (rosettes), and Granello (globes). He gives some sixty different snow figures in his illustrations. A fac-simile is given of the first ten figures of the class Rosetta.

The comprehensive work of the Holland physician, Jan Engelman, deserves especial attention. It contains twenty-eight plates, showing four hundred and twenty snow crystals, observed by him during the hard winter of 1740. Many of Engelman's figures deviate so much from the hexagonal system that it must be assumed as an error in observation or drawing. His book, which contained more theology than physics and meteorology, found such favor with the public that, twenty-four years later, a second edition was published. Just as improbable are many of the representations of snow figures in the "Hydrologie" of the Swedish scholar, J. G. Wallerius, who, in his over-zeal to systematize all water, whether flowing or frozen, stated that there were ten different species of snow. Somewhat later, we have the investigations of his countryman, J. R. Wilcke, which are of great interest, because he was the first, to my knowledge, to produce snow crystals artificially.

In the year 1820 the English whaler later the theologian, William Scoresby, published "An Account of the Arctic Regions." The keenness of his observations, and the excellence of their reproduction in ninety-six figures, the clearness of his statements, and the successful attempt to classify tbe crystals under five heads, have given to Scoresby's idea of snow figures the widest reputation. There is scarcely a text book on physics or meteorology which does not more or less fully describe Scoresby's classification, and give some of his illustrations. His classification is as follows: 1. Lamellar. 2. A lamellar or spherical nucleus, with spinous ramifications in different planes. 3. Fine spiculae, or six-sided prisms. 4. Hexagonal pyramids. 5. Spiculae, having one or both extremities affixed to the center of a lamellar crystal. Of class 4, hexagonal pyramids, he says: "This kind of snow crystal I have seen but once. These pyramids were about the thirtieth part of an inch in heigbt, and fell along with some other curious figures, during a fresh gale of wind from the northward, in

Fig. 1A.

very large quantity." Figs. 44 and 47 represent this kind of crystal. Of the last class he says: "This is the most singular genus I have ever seen, and has been observed but twice. It resembles a pair of wheels united by an axletree; the wheels consisting of hexagonal or other lamellar crystals, and the axle of a slender prism. Figs. 43, 45, 46 and 48 represent this modification of snow crystal. These figures were principally seen in a quantity of snow which fell on the deck of the ship in which I sailed. The temperature when this kind of crystal fell was in one instance 22° and in the other 20°." The fraction seen beside the numbers of the figures gives the diameter of the snow crystals in English inches. Scoresby believed that the form of the snow crystals depended in a certain degree upon the temperature of the air. The French mineralogist, Guettard, discovered this in 1762. In 1838 Karl Fritsch, of Prague, spoke of this, but in his "Observations" published in 1853, remarked that these relations were doubtful. The beautifully executed representations by James Glaisher, the English meteorologist, which are given, are little known because they were only published in a report of the British Meteorological Society for 1855. Glaisher sketched in four weeks more than one hundred and fifty different snow figures, which his wife copied with the greatest care, and completed according to the fundamental laws of symmetry. These drawings represent snow crystals in an ideal purity, delicacy and perfectness as nature never presents them to the human eye. It might be possible thus to see a single snow crystal at the moment of its creation, but we seldom obtain a sight of them in this state. I found out after many years of painstaking investigation that it was impossible to make accurate drawings of snow crystals as they really appear, and, therefore, greatly desired to procure photographs of them.

Dr. Neuhass, in the winter of 1892–1893, made some photomicrographs of snow crystals, in Berlin, which he very kindly placed at my disposal. I have made a selection from them and have reproduced Figs. 1 to 12. In the latter part of the year 1892 some of these photographs were photo-engraved for the *Scientific Journal of Microscopy*. These are to my knowledge the first micro-photographs of snow crystals ever published. Herr Nordenskiold made microphotographs of snow crystals about this time in Stockholm, which were published in March, 1893. Dr. Neuhass says he used a Zeiss projecting microscope, 31 mm. focal distance, and a small petroleum lamp as a source of illumination. He gave an exposure of 5 to 7 seconds, using Sachs orthochromatic plates. Although the lamp was placed 80 cm. from the objective table, and the image of the light was projected a few centimeters behind the focal plane, by means of an illuminator, and in spite of a temperature of —5° to —10° R. the heating of the object was such that the crystals began to melt in a few seconds. After the insertion of a cell filled with a solution of alum tbey remained unchanged for a little time. The alum solution froze at —5° R., and could only be kept in a fluid state by the addition of a quantity of salt.

A great difference can be distinctly perceived between these photographs and the drawings of Engelmann, Nettis, Wilcke, Scoresby and Glaisher. At first, perhaps, we will not be inclined to give preference to the photographs. We miss the absolute regularity and perfect symmetry which are found in the drawings. But herein lies the superiority of the photographs. We have now no longer ideal forms and

Fig. 1.

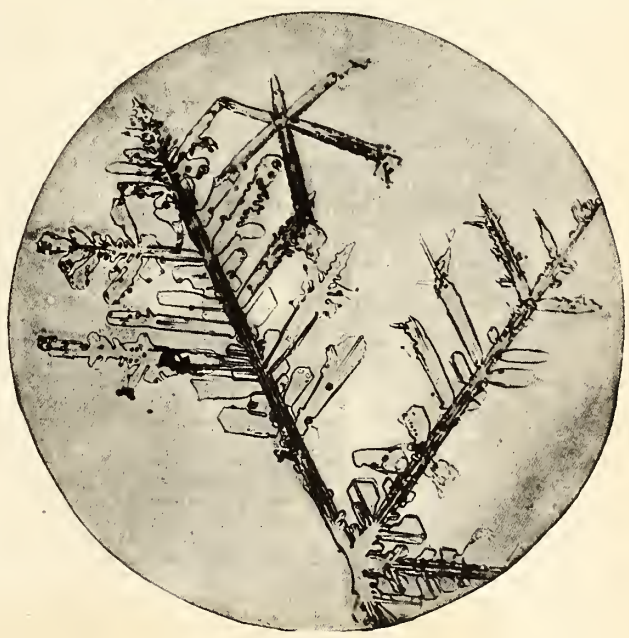


Fig. 2.

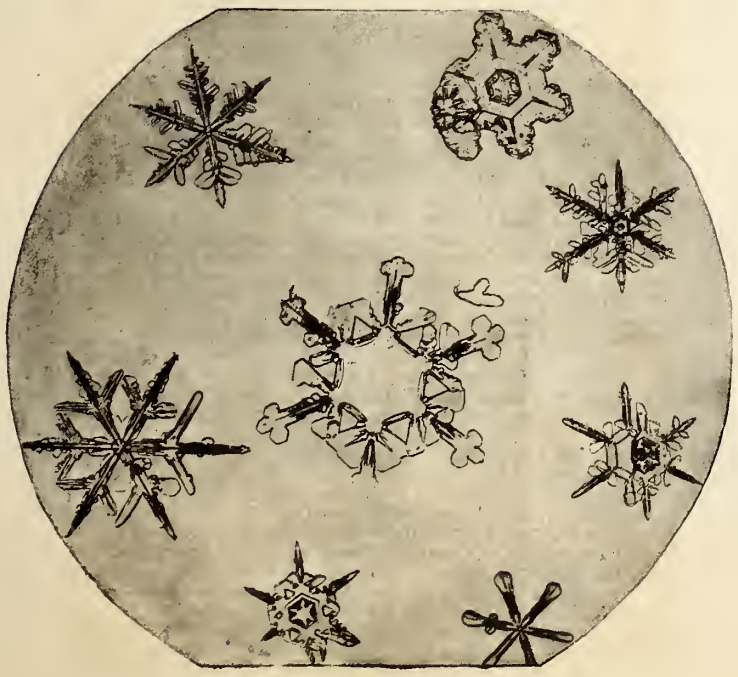


Fig. 3.

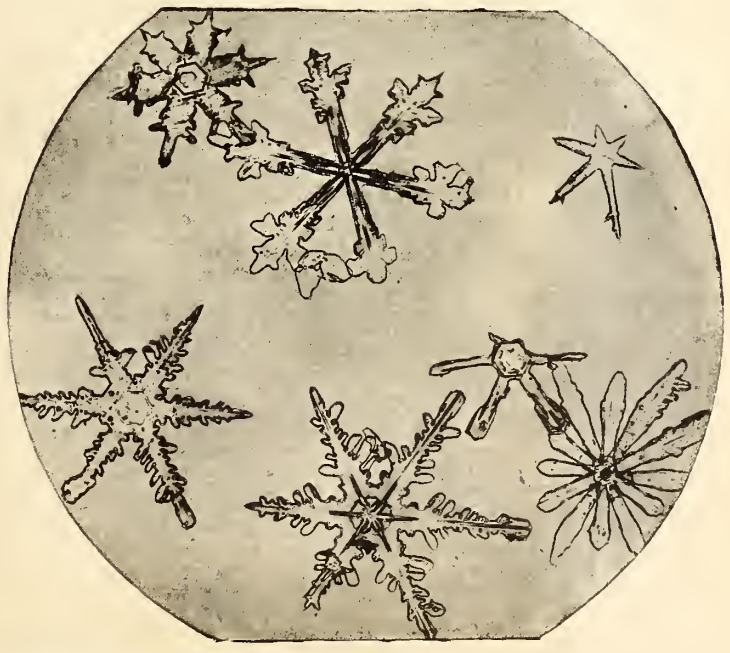


Fig. 4.

PHOTOMICROGRAPHS OF SNOW CRYSTALS.

perfectly symmetrical figures before us, but real images as nature offers them to us.

The deviations from the regular geometrical forms and the irregular and unsymmetrical forms may be due chiefly to two causes. First, snow crystals in their regular formation are frequently destroyed in the beginning. They meet with many disturbances on their way to the ground, from their place of origin. We know from all the theories of crystallization that regular crystals can only be formed when the active molecular powers can work unhindered in all directions. Now, if these conditions were fulfilled in the atmosphere, if, in their state of equipoise, there prevailed even one gentle motion, as is well known, it would expedite the separation of the crystals at the moment of crystallization. It is frequently the case at the time of snowfalls that the upper stratum of air is in violent motion. Even when it is very calm on the surface of the earth it is more or less windy in the region where the snow crystals are formed. So it is due to the wind that the first irregularity in snow crystals is brought about. The experience of investigators confirms this statement, because, in the calmest weather, the most beautiful and regular snow crystals may be observed. The second cause of irregularity is the disturbance of the snow figures by falling to the earth from their place of origin. The injury which the crystals inflict upon one another by coming into collision is naturally greater in a strong wind. The probability of such injury is lessened when the crystals are formed at less height, and, consequently, have a shorter distance to travel over when falling. Observation confirms this, for when, upon low-lying vapor or mist, through which the blue sky may be seen, isolated snow crystals separate, they are especially regular in form. This occurs very rarely with us, but it frequently happens in the polar regions.

There are three kinds of irregularity which lay claim to our attention, viz.: Incomplete development, injured crystals, and unsymmetrical crystals.

Our photographs not only show that these anomalies exist, but they may also be shown by measurement, which has been quite impossible heretofore with drawings of snow crystals.

An accurate measurement of the snow crystals contained in Figs. 1 to 12 shows that only four are quite regular—the beautiful star at the lower edge of Fig. 1, the small hexagonal plate at the upper edge of Fig. 9, which has a diameter of only 0·3 mm., the hexagonal plate on the lower edge of Fig. 9, whose three diameters are 0·782, 0·780, 0·745 mm. in length, and the star-shaped plate at the upper edge of Fig. 11, with the diameters 1·985, 1·985, 1·935 mm. All the other figures show a much greater difference in their dimensions. With the ray-like stars, the rays are frequently of unequal length. Plate-shaped crystals have often unequal sides. Of the hexagonal plate-shaped crystals with unequal sides, there are two distinct types, oblong hexagonals, with two long parallel sides and four shorter sides, and hexagonals of which the alternate sides are of equal length. An example of the first kind may be seen in the center of the large star in Fig. 5, and also in the four stars in Fig. 6, with a plate-shaped spreading of the points of the rays. In all five cases the hexagonal plate lies eccentric to the central point of the principal star. The difference in the length of the longer and shorter sides may be plainly seen in the star at the top of Fig. 6, where the longer sides are more than double the length of the shorter sides (0·4 and 0·19 mm.)

Of the earlier observers of snow crystals, Rohrer seems to be the only one who noticed and illustrated these oblong hexagonal plates. A beautiful example of the second kind of hexagonal plate is shown in the crystal at the left in Fig. 8. The inner hexagonal with sharp edges has alternate sides of 0·9 and 0·7 mm. in length.

Deformations are to be found in almost every plate. The most striking appear in the large star in Fig. 1, where probably some external interference displaced one of the principal rays, and in the upper hexagonal plate in Fig. 8. Here the inner hexagonal shows a distinct deformation, perhaps in consequence of melting on one side in the state of development, and subsequently forming anew. This or any similar occurrence must have happened before the formation of the secondary rays, otherwise they could not have shot out so far from the principal ray.

In all the drawings of star-shaped snow crystals published until now, the secondary rays, starting from each side of the principal ray, at the same point, have been of equal length; wherefore the figures have been perfectly symmetrical. In reality this is not always the case. The secondary rays are often unequal in length, and are not always exactly opposite each other, as may be seen in the stars in Figs. 1, 1*a*, 2, 5, 6, 11, and 12. Another form of unsymmetrical crystal may be seen in Fig. 6, where there is a combination of the star and plate.

(*To be continued.*)

## THE EFFECTS ON THE VOCAL CHORDS OF IMPROPER METHOD IN SINGING.*

By H. Holbrook Curtis, M.D.

It would be strange, indeed, if a laryngologist who was daily in the habit of examining very many throats of singers did not have his attention particularly attracted to the difference in the appearance of the glottis as the direct result of different methods of voice production. Several years ago—as early as 1884—I observed that many pupils of a certain professor of singing presented marked peculiarities in regard to the position of the free borders of the vocal bands. The slightly elliptical shape of the chink of the glottis which this class of pupils presented in emitting the usual sounds to allow the proper view of the larynx led me to inquire as to the particular method of teaching which would produce in so many throats a typical appearance. I soon found out that these pupils were in the habit of taking daily exercises almost entirely on a single vowel, and that single vowel being the letter "O." The vocal chords appeared striated, with frequently a congested area at their anterior attachment. Frequently a nodule, more or less defined, would be observed about the center of the free edges on either chord; this is a picture which every laryngologist will recognize. Another type, of which the study is most interesting, is that of a class of pupils undergoing instruction at a conservatory where that pernicious French method, the so-called stroke of the glottis (*coup de glotte*), is daily practiced. In this type the writer has observed the middle third of the chords to be slightly bulged, the chords presenting a convexity in contradistinction to the concavity exhibited in the last group. These pupils had been singing chiefly on the vowel "A," pronounced as "ah" in English, and with the emission of each note the middle portion of the chords would clash, and, by constant attrition, become hardened and callous. The chords in this particular type do not usually show congestion; their appearance is usually of a good pearl color and healthy looking in every way. The complaint which they make upon consultation is a difficulty in singing the so called *mezzo voce* and a lack of richness of tone and *timbre*, with extreme weakness of two or three notes in the upper-medium register. It was these two opposite appearances of vocal chords, which are every day observed in singers' throats, that led to an investigation of methods employed by the various schools of singing, and has opened up a field which I think has been entirely neglected, though of the greatest importance to every laryngologist who has to do with the singing voice.

Two names are intimately linked with the traditions of method in singing—those of the elder Lamperti (that illustrious exponent of the best Italian school) and Mandl, who, by his ingenious arguments, though founded on a false physiological basis, succeeded in completely overturning the art of voice production which previously had been taught throughout Europe. He substituted in place of the so-called Italian school a method of abdominal respiration, which was at once adopted in the Paris conservatory and has obtained to within the last three years an almost universal recognition in the best schools of the Continent.

It is the writer's purpose, without going too deeply into the history of singing, to discuss the various methods of respiration and initial tone production, and to show by a series of experiments made upon individuals the effects of certain methods of voice building, hoping to arrive at some definite conclusion as regards the proper exercise and position of the larynx, and consequently proper tension of the vocal chords during tone emission. For the brief historical sketch which I shall give I am indebted almost entirely to the able article article of Dr. Joal, of Mont Dore, which appeared in the *Revue de laryngologie, d'otologie et de rhinologie*, Nos. 8, 9 and 10, Paris, 1892. The position which Dr. Joal occupies at Mont Dore (the favorite resort of almost all the European artists) has enabled him to consult freely for a number of years the most distinguished vocal talent in Europe, and his views upon voice production should be carefully read by every instructor who wishes to profit by the exceptional opportunities which that author has enjoyed. One cannot read his able discourse upon the singing voice without feeling that his every utterance is *ex cathedra.*

In 1842 Beau and Maissait divided the respiration of singers into three characteristic types—the superior costal, inferior costal and abdominal. The superior costal may be illustrated as the breathing of a woman tightly laced, the respiratory expansion taking place chiefly in the cone of the thoracic cavity, the upper ribs, collar bone and sternum rising and falling during the respiratory act. In the inferior costal type the inferior ribs (commencing with the seventh downward) are rotated and elevated, the sternum moving only in its inferior portion, the abdominal wall being contracted during the inspiratory act. In the true abdominal type the thorax is supposed to remain completely fixed, the diaphragm taking the ribs as a fixed point, lowering the abdominal viscera, thus distending the wall of the abdomen in inspiration. It is this latter type of breathing which has been taught for the last thirty years in France.

Mengozzi, together with the masters of one of the conservatories, determined upon the following rules illustrative of the breathing of singers: "The respiratory act in singing differs somewhat from that used in speaking. In speaking the abdomen is distended in inspiration and recedes in expiration, while in singing the abdomen must be drawn in during inspiration, returning slowly to its natural state as the chest contracts in expiration, thus retaining as a negative force the air which has been introduced into the lungs."

In a revision of this method, published in 1866 by Baptiste, these laws are repeated, with the addition of a note by Dr. Mandl (the apostle of abdominal respiration), who advocates the advancing of the abdomen in inspiration. Mandl carried his point and his ideas became generally adopted by the conservatory. M. Bonheur and Dr. Cheval, of Brussels, advocated the superior costal type of breathing, in contradistinction to the method of Mandl. Mandl in his work states that the larynx becomes very much depressed and the glottis enlarged in the costal method of respiration. Joal answers him in these words: "We do not find this depression of the larynx referred to in any of our classical treatises on physiology, anatomy or in any of the numerous works which have appeared since 1855 on laryngology; consequently, we suppose that writers do not share the ideas of Mandl on the subject. Besides, we have examined a number of persons whom we engaged to breathe alternately from the abdomen and from the shoulders. We ourselves, in singing, have often observed the movements of our larynx, and we have never observed that the clavicular inspiration caused the thyreoid to fall." Nicaise explains this fact by demonstrating, experimentally, that during strong inspiration the trachea contracts and becomes shorter, which draws down the larynx.*

It is very difficult for a professional man to take cases of distinguished singers in his own private practice and hold them up by name as models of perfection of certain types. Joal made the assertion in an article published in 1890, that great artists, especially women, used the superior costal method. The distinguished critic of *Le Temps* challenged Dr. Joal at once to mention some of these artists. The doctor responded: "I would be happy to gratify Mr. Weber's desire, but it is very difficult for a physician to go into personalities and to say that a certain singer is using a vocal method considered disastrous and execrable by masters of criticism." Melchissedec, however, offered himself as an example of the superior costal respiration, saying that it had enabled him to sing constantly for twenty-five years. Both his strength of tone and tremendous endurance, with an almost perfect glottis, attest that the method has not been injurious to him.

The abdominal method of breathing has many powerful advocates; M. Obin and M. Faure, for example, speak most highly of it; Shakespeare, of London, Behnke, and Lennox-Browne are also its advocates. The instructors of both methods are very apt to quote great artists as the exponents of their particular school. Joal cites the case of Rubini, the celebrated tenor, whom Massini and his pupils declare originated abdominal respiration. Bonheur, on the contrary, states that he expanded his upper chest, Walshe even going so far as to say that he fractured his collar bone in making a violent effort to reach "B flat" in *The Talisman* of Pacini. Lablache and Laget acknowledged that, in spite of long and attentive observation, they had not been able to distinguish in the theater how this illustrious tenor breathed. Joal goes on to state that the famous Lamperti is alternately represented as a partisan or opponent of the abdominal type of breathing, but I think that, having treated many of the elder Lamperti's pupils and interrogated them very particularly upon this question, I may unhesitatingly affirm that the elder Lamperti was a strong advocate of the lower costal respiration, always arguing that the abdominal wall should remain quiet, or should be slightly drawn in during inspiration. The evidence of Campanini, Jean de Reszke and Clara Heyen is in support of the foregoing. Joal says if we except the works of Laget and Bonheur, we find nowhere the praise of clavicular breathing in men. The ancient method of the Paris conservatory and the works of Maunstein, Caruth and Manuel Garcia, all advise thoracic respiration by the elevation of the ribs and drawing in of the abdomen.

If we take up any work on the voice and study the photographic appearances of the chords during the emission of certain notes, we remark that the chords are not vibrating longitudinally, but that their free borders approximate, touch, or overlap, and that the posterior opening of the chink is longer or shorter and different in appearance for each note. I wish to put on record here my opinion of the absolute impossibility of photographing the vocal chords during the proper emission of tone, from the very fact that the laryngoscopic mirror placed in the pharynx interferes with the right focus of the respiratory attack, and it is only possible to observe the vocal chords in the photograph when the so-called stroke of the glottis is used in the emission of a note. The photographs of singers' chords and the deductions which have been drawn from their appearance during the emission of different notes only demonstrate, in every case that I have ever seen, that the larynx is elevated by the pulling up of the thyreoid, the chords relaxed and the free borders more or less approximated.

If we ask a singer who is in the habit of using the so-called high chest method of costal respiration to take a note (the attack entirely taken from the chords and focused in the masque, bringing into play the harmonics lent by the sound waves passing behind the uvula and soft palate), introducing the smallest possible size of mirror, so that the color given to the note by Nature's resonance pipes, the antra and nasal cavities, will be as little as possible interfered with, we are surprised to find that on the emission of every note of the soprano medium register the chords appear equidistant from each other throughout the entire extent that it is possible to see them.

The part which the intrinsic muscles of the larynx play in the tension of the vocal chords becomes an interesting study. It is very easy for us to see by the depression of the thyreoid how the chords must be elongated, but it is extremely difficult for us to comprehend the minute differences of tension caused by the movements of the thyreo-arytænoid and crico-arytænoid muscles. I have frequently been surprised upon examination of the vocal chords with the head held down, the chin resting upon the chest, to find the chords present a beautiful pearly appearance, entirely homogeneous; but upon attempting to show the patient his own chords by an adjustment of double mirrors, the head being slightly thrown back, upon the same note the chords suddenly have become dusky, semi-congested and striated. How much of this is due to the slight elevation of the thyreoid cartilage and how much to the intrinsic muscles of the larynx, or to the relationship between the chink of the glottis and the trachea, it is difficult to determine. To a careful study of these differences of tension am I indebted for the discovery of a fact which I here write about for the first time. the appreciation of which fact, however, has entirely changed my treatment of the singing larynx, and has caused me to institute a system of tone exercises by which certain intrinsic muscles of the larynx are so strengthened that any medical application through the medium of sprays, probangs, and, I may say, instrumentation, has ofttimes been entirely done away with.

If we take a good sized laryngoscopic mirror—No. 4, for example—and ask a patient to sing "E" or "Ah," the chords come into view for two reasons: First, the epiglottis becomes more perpendicular, allowing a better view of the bands; and secondly, the chords themselves are on a more elevated plane, owing to a slight elevation of the thyreoid cartilage and consequent relaxation of the intrinsic tensors of the chords. In this position we remark that the free borders of the chords come together in the anterior and central portions, and we are able to study the initial tone attack, the membrane separating as the tone bursts through the closed chink. This picture may be said to be an imitation, on a small scale, of the so-called stroke of the glottis. In this method of producing a tone, the initial attack being upon the chords themselves, the central portions of the chords necessarily touch. The peculiar muscular equilibrium which is employed in this mode of attack invites a reflex elevation of the soft palate, cutting off the oral from the nasal cavities. As we look at this picture our minds revert to the singing teacher who commands her pupils to keep their palates up, sing in the back of their heads and strike the glottis. Could ever villainy be more compounded? Let us take the same patient and require him to sing the same note, but in an entirely different way. We will first

* Read before the First Pan-American Medical Congress, September, 1893. —*N. Y. Med. Jour.*

* *Revue de medecine*, 1889.

ask him to expand his upper chest, not necessarily by respiration, but by elevation of the superior ribs by a muscular effort, at the same time slightly drawing in the abdominal wall. We now introduce the smallest mirror and ask our patient to sing "A," pronounced as in law or maw. With this position of the larynx and muscular poise we observe two things: First, the epiglottis does not assume its most vertical aspect, not inclining as near the perpendicular, and the soft palate and uvula do not spring upward and backward to make the partition between the mouth and naso-pharynx. Different in every respect is the tone produced by the chords, which may be assumed to vibrate longitudinally, but never touching each other in the middle portion, even in making the initial attack. The chords appear narrower, tenser, lower anteriorly, equidistant from each other, more homogeneous and whiter in color.

These two pictures should be well considered, as they become the basis of criticism in distinguishing the correct and eliminating incorrect methods, on the one hand, in singers' voices, and of the greatest assistance to the laryngologist in correcting pathological conditions, the result of bad training. The proper appreciation of these opposite conditions and their effect on the quality of tone immediately calls our attention to the subject of respiration. Within the past three years the entire theory of musical education has changed in France, the explanation of this change being that there is at present a better appreciation of the influences bearing upon the production of tone and a better understanding of the physiology of the larynx, by reason of the advances made in laryngoscopy.

Modern teaching tends to cultivate tone harmonies and sympathy in the voice at the expense of brilliancy of execution. The same judgment should be exercised in the training of an individual who proposes to make singing his or her art as should be employed in advising the painter that his special *forte* lies in landscapes rich in color, in which he may give expression to his imaginative genius, rather than to the sterner *facsimile* of portraiture.

How many singers we hear whose technique and brilliant staccato in the Bell Song of Lakme calls forth our admiration and amazement, but who are absolutely unable to put any sympathy whatsoever into the simplest ballad! We should study color harmonies in music in the same way that they must be studied in painting. There is no rule for the palpitating sunlight effects and prismatic play of colors in the school of Claude Monet; it is certainly a subtile feeling which is given by an ingenious mingling of pure spectrum colors. In the human voice that added coloring of tone which appeals to the heart as well as to the ear of the listener must be brought about by the employment of those harmonics which are added to the original tone by intervibrations within the accessory cavities of the nasal passages. To sing *dans le masque*, as the French say, is to give this added richness to the initial tone; but to sing in this manner requires the soft palate and uvula to be lowered in the production of tone. Likewise to make the purest initial tone from the chords, we must get the utmost possible tension, which may only be arrived at when the thyreoid is depressed, for, in proportion as the thyreoid is elevated, the chords tend to assume the base of a right angle triangle instead of its hypotenuse. Several elements besides this enter into the question of greatest possible tension, one of the most important of which is that the trachea be drawn down to assume the position that it takes when the apices of the lungs are filled to their greatest extent with air.

One of the greatest singers the world has ever known told me that the reason that he adopted a fixed high chest was that he had found, after the removal of a papilloma from one of his chords, that the only way in which he could be at all sure of his voice while singing was by the maintenance of the so-called high chest respiration. This is easily explained by the fact that in this position, the upper ribs remaining fixed, the apices of the lungs always remain in contact with the thoracic wall, expanded to their fullest extent, the chords being kept in their state of greatest possible tension. In this position the breathing becomes entirely inferior costal and diaphragmatic. The position of the thorax, as indicated above, permits the lungs to expand to their fullest extent, thus adding a secondary resonance to the voice from below—a sort of complementary *timbre*, the fixed upper thorax allowing of the least possible change of color during tone production.

It is this combination of facial and thoracic tone fortification which gives the enormous carrying power to tones produced by this method. For a number of years before I made a special study and estimated the great significance of these factors in singing, I deluged the throats of singers with sedative and astringent sprays when their chords appeared congested and swollen, often presenting nodules in their center which I had never previously recognized as being due entirely to singing with an improperly poised larynx.

I may cite several cases to show you the difference, from a medical standpoint, in the treatment of the singer's throat, where I now substitute respiratory and tone exercise for the amelioration of conditions that I have always been taught were only to be cured by rest and the diligent use of drugs. The cases I cite are typical of a class of singers that I have treated with equally good results since I have made a particular study of the peculiar value of the proper tone production in the human voice.

CASE I.—The first day of January last I was consulted by Miss F., aged twenty-three years, who had had a contralto voice of large power which she had employed constantly for several years, and had finally, after a prolonged concert tour with a well-known orchestra, entirely broken down. Her chords were dark red, with a slight nodule in the middle of either band; she complained of great pain in producing her notes, and her medium register had no power in it whatsoever. She had been told by two of the best authorities on the throat that she must not sing a note for a year, and must have her chords painted with astringent solutions and tone up her general health. Upon testing her voice, I remarked an extremely breathy tone and clavicular respiration.

In accordance with the principles which I have attempted to demonstrate, I forbade her speaking a single word for a week, but placed her at once upon the so-called inferior costal respiration, maintaining a high chest, and giving her directions to take a medium "C," with the chin almost resting upon the clavicle, singing the word "ma" for five minutes of each hour of the day, the two first to be focused in the face with the mouth closed, and the attack to break upon the lips as much as possible on opening the mouth. At the end of seven days the chords, instead of presenting an elliptical appearance, were straight, and the nodule was so far rotated upward on either chord that it did not touch the nodule of the opposite side in the emission of tone. At the end of the week this young lady, who considered her voice hopelessly destroyed, having acquired a new method of respiration, sang in a concert. She has since sung regularly in church, in many oratorios during the winter, and is at present singing three times a week in grand opera, learning new *roles* continually, apparently perfectly restored. She tells me her voice is far more powerful than she had ever dreamed of.

CASE II.—Miss P. H. consulted me on March 2 in great distress. She was obliged to sing in a comic opera on that evening or close the theater. Examination showed inflamed and bulged chords, with great hoarseness in the speaking voice; middle register impossible, but the high notes obtained with great effort. I sent her at once to my assistant, who gave her exercises to maintain tension, and at the end of an hour's work with tension exercises and inferior costal breathing the cords responded and she sang with ease.

CASE III.—Miss H. B. consulted me in May, having lost her position as prima donna by reason of loss of voice. Had been constantly treated. Her chords showed the nodules of attrition, the result of the employment of the *coup de glotte* and faulty respiration. In this case a week's work caused the nodules to disappear. She adopted a proper laryngeal poise and again assumed the leading *role*.

*Observation.*—In this class of cases rest causes a relaxation of the chords and singing becomes impossible for some time, whereas constant work, with tension of the chords and non-approximation of the same, gives immediate relief.

CASE IV.—Fraulein K. consulted me in the spring. Her chords appeared swollen and the membrane was injured, but not hyperæmic. Had been obliged to cancel her engagements and return to New York for treatment. I recognized the familiar picture and sent her to my assistant, who cured her in a week without other treatment than the establishment of a proper laryngeal poise.

With many cases like these which I might cite, may I not be excused in my assumption in calling attention to what I consider the most important ground principle of the singer's art—namely, the proper employment of the muscles of respiration, the poise given the chords and the proper use of the intrinsic muscles of the larynx, not forgetting the bringing into play of the accessory cavities of the face, which lend so much color to the tone, removing entirely from the chords the deleterious effects of an improper initial attack?

To rehearse briefly the deductions which I have attempted to draw from my argument, I maintain that the best method of respiration is the inferior costal or diaphragmatic, faithfully maintaining the elevation of the upper ribs without raising the shoulders. Next in importance is the depression of the thyreoid cartilage, brought about through the agency of the crico-thyreoid muscles and the pulling down of the trachea, by increasing the capacity of the upper lobes of the lungs—anatomically speaking, a pose causing the thyreo-arytænoid muscles to produce tension instead of the crico-arytænoids. Be careful that the initial attack is removed entirely from the chords. Lower the uvula and soft palate, that the sound waves may obtain their intercurrent vibrations or harmonics by partly passing into the nasal cavities from behind. Let us not fall into the error that the roof of the mouth alone is the sounding board of the singing voice, for without that added richness and *timbre* to be given by calling into play nature's resonance pipes, the nose and its accessory cavities, we may sing, but the singing is at the expense of the chords, and the life of the voice is necessarily shortened.

If I have said enough to arouse a new interest in what I consider a most necessary accessory to laryngology, I shall feel amply repaid for my endeavors to set the theme before you in a clear and comprehensive manner.

## BOVINE TUBERCULOSIS.

By HENRY G. WOLCOTT, New York State Commissioner of Health.

IN a recent letter to the editor of the *Orange County Farmer*, State Commissioner Wolcott gives the most recent information on the above subject, as follows:

I have read with much interest in your issue of March 8 the statements relative to bovine turberculosis, and the efforts of the State Board of Health to call popular attention to the same.

Since comparatively little is generally known upon the subject, I think it may not be devoid of interest to your readers to learn some of the facts which have induced such efforts, and while in thus addressing you I shall have, necessarily, to indulge in the "scientific," I believe that all information upon this most important subject is worthy of attention.

Bovine tuberculosis is practically the equivalent of the like disease in humans, be it known as pulmonary tuberculosis or consumption, as lupus, as tuberculous fistulas, as scrofuletic affections, or under many other names familiar to the medical profession, varying in name with the symptoms or part affected. In all such cases the cause of the disease is the "bacillis tuberculosis," a microscopic vegetable parasite, in shape like a bit of very fine thread, and when viewed through a microscope of say 1,300 diameters, appears to be about a sixteenth of an inch in length. These germs increase by segmentation, that is, they break up, and each thread-like piece is capable, under favoring circumstances, of lengthening, breaking, and in time producing others. They do not multiply except in living tissue or in animal products, such as blood, serum, beef broth, or the like; and while they may live for years outside the animal or its products and be capable of producing the disease, still sunlight will destroy them in the course of a few hours. Nature has thus put a limit to their destructibility, and has also given to healthy animal tissue, in the great majority of cases, the power of expelling or annihilating the germ, else tubercular affections would be far more prevalent than at present.

The importance of this germ theory of disease as applied to tuberculosis is thus clearly recognizable, and to Prof. Koch is due all credit, for the discovery is distinctively his. It is now classified by our best sanitarians as a "preventable disease," and in the same category as diphtheria, smallpox, scarlet fever, etc. The importance of this discovery is emphasized by the fact that about thirteen deaths out of every hundred are caused by some form of this disease.

Viewed solely from its sanitary standpoint, this discovery marks an era in the nineteenth century. That the cause of this disease and the disease itself exist in cattle, that cattle can communicate it to members of the human race and to other cattle, is without doubt. That it can be communicated from man to cattle is also acknowledged. That it may be, and in many cases is, hereditary, is also established; or, if not always hereditary, the offspring of tuberculous parents are more susceptible to its influence than are the offspring of non-tuberculous parents.

There are within the State of New York about a million and a half of milch cows, and about two and a half million of animals whose annual dairy product exceeds $35,000,000. The records of the State Board of Health show that 3½ per cent. of all cattle examined are tuberculous. Hence, looking at the question from a pecuniary point of view solely, how vast the interests affected. Considered from both the sanitary and pecuniary standpoints, how momentous a question this proves itself to be.

The cause of all this trouble, the bacilli tuberculosis of Koch, is readily isolated from other bacilli. A dilute solution of nitric acid has no effect upon them, while destroying other germs. Again, a dye known as "carbol fucine" will stain them a dull red, having little or no effect upon other bacilli. If, then, upon a microscopical examination, we find them in diseased tissue, inoculate healthy tissue with them, again finding the specific germ, and carry this operation on through seventy different series of animal cultures, taking proper antiseptic precautions in every case, and have the seventieth subject die from symptoms tuberculous in their nature, still finding the same specific bacilli, we may reasonably conclude that it is the cause, and not the result of the disease. This has been done by Prof. Koch and other observers, and the results as stated established and acknowledged as facts. The only animals, so far as known, upon which such inoculations have no effect are rats and mice. Guinea pigs and rabbits are particularly susceptible to its influence, and upon them the great majority of experiments have been made.

The contamination from the human to the human or to the bovine is presumably by the sputa, which, when dried, permits the bacilli to be carried by the air, and when a suitable lodgment is found in susceptible tissue, either in the respiratory or alimentary tracts, germination and increase may result, producing a tubercular affection, specifically named in accordance with the organs affected. The communication from the bovine to the adult bovine is by the sputa mainly, the well known habits of cows licking each other, feeding from the same troughs, etc., being familiar examples. Calves frequently take it in their mother's milk. It is mainly communicated from the bovine to the human through the milk.

While it may be communicated through tuberculous meat, the fact that meat is usually cooked and that a temperature of 160° Fah. is maintained will destroy the bacilli and prevent much danger on this score. A tuberculous cow may or may not have tuberculous milk, depending in measure upon the part affected, and the extent to which the disease has developed. When the mammillary or milk glands are so diseased, the milk is generally tuberculous. The certainty that a tuberculous cow having non-tuberculous milk at the time of observation will, during her life, limited at the best to a few months or years, prove a source of contagion to all remaining healthy members of the herd, the fact that her milk may at any time become tuberculous, and the further fact of her progeny being probably tuberculous, would warrant her destruction. A tuberculous bull is not a fit animal to breed from, no matter how phenomenal his record as a progenitor of milk-producing cows. It is a curious fact that butter when made by either the separator or ordinary methods seldom contains tubercular germs even when made from milk known to be tuberculous. The reason for this doubtless is that the specific bacilli referred to are heavier than the milk surrounding them, and fail to become entangled in the lighter or butter-producing portion. This fact enables the skilled pathologist to the more readily find the bacilli by using a centrifugal apparatus which concentrates them in a certain portion of the fluid under examination.

About two years ago the State Board of Health, recognizing the important bearing of the facts above mentioned, commenced its crusade of enlightenment. It takes to itself no little credit that among all the States of the Union it was the first to establish a department devoted solely to this work, where the latest and most authentic information upon the subject could be collected and collated, and where the correctness of theoretical deductions, based upon such facts, could be practically proved or disproved. Pennsylvania, Rhode Island, Massachusetts and sister States are now following in our lead, and the Bureau of Animal Industry in Washington, D. C., is exhaustively examining the question.

The use of Koch's tuberculine or lymph as a diagnostic agent in cases of suspected tuberculosis has vastly increased the possibilities of eradicating the disease. Many fallacious notions exist as to this tuberculine and its effects upon the animal inoculated. In the hands of a skilled, conscientious and experienced specialist, it can effect no possible injury. It will not cause the disease, nor will it increase the disease in affected animals. In unskillful hands it is likely to give results that are not borne out by the *post mortem* examinations. In the hands of a skilled, conscientious and experienced specialist the information it gives may almost be said to be infallible.

There are as yet certain attendant facts and circumstances connected with the correct readings of the indications it gives that make the information obtained by physical examinations important in doubtful cases,

and while the State Board of Health uses its best endeavors to obtain inspectors who shall fulfill all the requirements of the ideal inspector, still the limited annual appropriation of ten thousand dollars will not permit of its paying salaries to its inspectors commensurate with the skill and experience demanded. The faulty diagnosis, as evidenced by the *post mortem* examinations amounting thus far to about three per cent. of the animals slaughtered, is due not to errors in the principle employed, but to errors in the method, carelessness or ignorance on the part of the user of such principles, and in nowise affects the efficiency of the tuberculine test as a diagnostic agent.

The tuberculine is imported into this country, and although the department in Washington has the formula for its production, still the febrile reaction of the two brands differs. Just what or how the tuberculine is produced is not generally known. It is generally believed to be a ptomaine of the bacilli tuberculosis in pure glycerine.

We will suppose that the owner of a herd of say forty head has, during the past year, unaccountably lost two or three animals. Some of his cows have rough coats, feverish eyes, are thin and low spirited. The milk supply may be normal or even increased. Two or three have a cough, and to sum it up the owner would say his cows are "sick." He hears of consumption among cattle and writes to the State Board of Health at Albany, asking that an examination be made of his cattle at the expense of the State. After waiting several months (we have over fifty applications on file and unattended to), he receives notice that on a certain day the inspector will make an examination. He is asked how long since his cattle first became "sick." Inquiry as to cattle purchased at or before such first sickness will be made, and the chances are more than even that the purchased animal came from a herd known to be tuberculous. The cattle are then numbered, examined physically with much care, and the results entered.

If the facts warrant it, the cattle are thereupon tagged and quarantined. The owner is directed to remove all cows within two weeks of calving, and all cows bulling unless the physical examination clearly shows them to be tuberculous. The reason for this is that the tuberculine test is apt to give undue reactions in such cases and to similarly feed and water his entire remaining herd. One hour after feeding the temperatures of all animals are to be taken by thermometers, the similarity of whose readings under similar changes of temperature the inspector has previously established. He will take temperatures five hours thereafter and again at ten hours. During the interim the cattle are to be neither fed nor watered. Careful entries are to be made of all results so obtained.

He will then order the cattle well fed and watered and will proceed to inoculate the animals with tuberculine, using his judgment as to the amount to be injected, based upon the weight of the animal to be tested. About seven hours thereafter he will again commence taking temperatures and without permitting feeding or watering take eight temperatures at intervals of two hours each, after which the test ceases and the animals may be fed and watered.

Now commences the real work of the inspector and upon which his reputation and the reputation of the board depends. The inspector will remember that temperatures are nearly two degrees lower between twelve and two at night than at midday, that free watering may reduce the temperature one and a half degrees, that a bull has two degrees higher temperature than a cow, and that chewing the cud is certain to run the mercury up at least one degree.

It is trying work, and the tendency is to let the doubtful cases remain under quarantine pending subsequent examination. This, however, is a hardship upon the owner, and should be, so far as possible, discouraged.

Depending upon the results of his study of the chart, he orders some freed from quarantine; some he continues under quarantine, and for some he orders killing cards from the ward in Albany. If the rise is spasmodic, resuming or approximating the normal as the tests continue, other things equal, the animal is non-tuberculous. If there is a gradual and regular rise, reaching its maximum at the seventh or eighth test and showing an increase of upward of three degrees above the normal, the animal is almost certainly tuberculous and should be killed. When received the cattle are killed under his direction and *post mortem* examinations made. The carcass is buried usually in quicklime or removed to a phosphate factory.

It is believed by the board that it as a body cannot alone ever eradicate this disease. The subject is too vast to seriously undertake. It wishes to bring the subject before the people, and let the individual or the local boards in co-operation with the State board attend to the details. It is hopeful that the health departments of cities will appreciate the importance of the subject and issue a quarantine against tuberculous milk. It hopes that in the near future a corps of specialists will be granted from our agricultural and veterinary colleges whose certificate of immunity will be a prerequisite to the possibility of sale, and that the ultimate result will be a material lessening of the death rate and a demand for the animals and dairy products from the State of New York by reason of their known freedom from disease.

## ROOSTING BUTTERFLIES.

By John T. Carrington.

Considering that more than half the span of life allotted by nature to the perfect state of butterflies is spent in sleep, it is of the first consequence that the manner of roosting should be as far as possible protective. Alert and well able to save themselves during the active period of their existence, when the sun is hot and their power of flight is strong, they are perfectly helpless in the dusk of evening, the night time, early morning and on dull days. Then we may pick them up with our fingers and place them on our hands without the slightest show of movement on the part of the insects. When in this condition of torpor or sleep induced by absence of sunlight, butterflies form an easy prey to prowling enemies, which may by chance take them before they have provided for the continuance of their species. Therefore, we must conclude that the habit of roosting adopted by each kind is most conducive to protection during the long hours of sleep.

When we take the list of the European Rhopalocera and scan it deliberately through, it is only possible to come to one conclusion upon the knowledge possessed as to the manner of roosting of the various butterflies. Indeed, we, in this country, need not take the whole European list if we are in search of discovery into the resting habits of these insects. Very little is really known about the roosting positions, from the protective point of view, of the majority of our British species. Most entomologists know how to hunt for several of our "blues," or Lycænidæ. Various kinds are to be found so soon as

PIERIS RAPÆ, ROOSTING ON PEA BLOSSOM.

the sun has set, resting upon the stems of grass; though not all the species affect the same position. Some species invariably rest with the head of the insect turned away from the earth, looking skyward, while other species always roost with the head looking downward. One wonders why nearly allied species, with the markings and ground color of the underside of the wings, which is the only side visible among this group when roosting, should invariably adopt these unlike positions on the stems of grass.

Some of the fritillaries (Argynnidæ) and *Melitæa* often affect the heads of flowers as the night resting place, though I fancy this is rather accidental than otherwise. It may be those frequenting the flowers at night were "caught" in that position by the sun going down while they were feeding off the honey in the flowers, as so often seen with humble bees. We cannot find a large proportion of say *Argynnis euphrosyne* or *Melitæa athalia* out of the total population of these species in any locality affected by them at rest on the flower heads. Still it is not uncommon to find both species in that position on a dull morning after a bright day. I have seen seventy of the latter kind on heads of thistle and other flowers in a single morning, in the great wood near Hailsham, in Sussex. So, likewise, may we find the grizzly skipper at rest, though chiefly on lower growing flower heads. *Hesperia comma* sits upon the smooth stems of young hazel boughs in woods, on the borders of the chalk downs where it flies, and *H. sylvanus* has much the same habit. Another of our skippers, *Nisoniades tages*, may be taken in sufficient abundance by searching the dead seed capsules of the plants of black knapweed of the previous year. This species roosts in a position quite unlike others of the group native to these islands. It folds its wings under the body, like a noctuid moth. On one evening, on the Horsley Sheep Lees in Surrey, I searched a dead plant of knapweed for varieties of this dingy skipper butterfly and took sixteen specimens off about ten seed heads. Being unable to find more, I shook the plant into my entomological net, with the result that four additional butterflies were shaken off. The protective position selected was so perfect that all my trained experience failed to show me the remaining four on the plant.

I quote Mr. F. W. Frohawk's notes, taken when he sketched the white butterfly sleeping on a pea flower, herein reproduced from his drawing.

"August 19, 1885, between 10 and 11 A. M., dull day, found *Pieris rapæ*, female, at rest on pea blossom, which it closely resembles and mimics both in form and color. It remained motionless until noon on the following day, when the sun shone for a short time, and it flew away. The similarity between the unexpanded blossoms and the resting butterfly was an excellent example of protective resemblance."

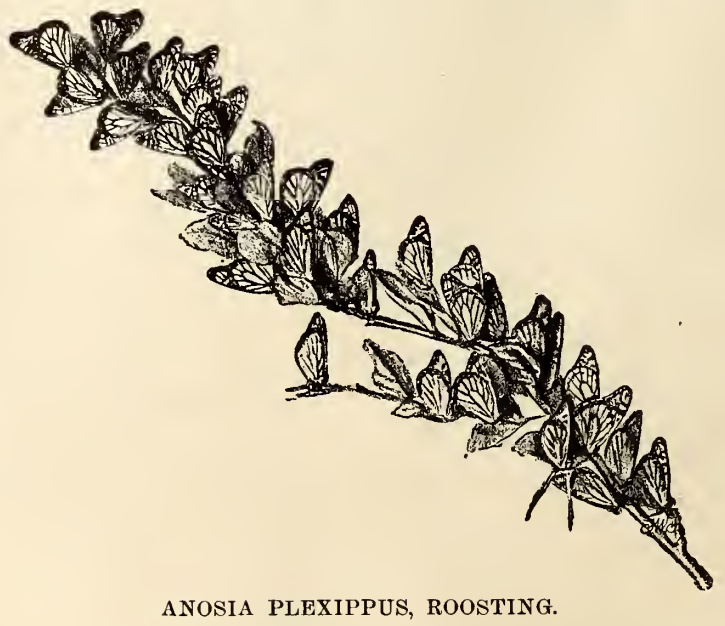
About three years ago I was visiting a house well covered with ivy of a variety with rather large leaves. One recently grown branch had developed a few whitish or cream colored leaves, as a "sport" among the ordinary green leaves. This branch being near the dining room window, was convenient for observation. Every evening for several days, about sunset, a large cabbage white butterfly (*Pieris brassicæ*) used to search out one of these half dozen white ivy leaves, and roost upon it for the night. The protective value of the creamy white leaf for the creamy white underside of the butterfly was perfect. The butterfly seemed to be the same individual on each evening.

The drawing of some three dozen Plexippus butterflies at rest on a dead branch of a shrub is taken from a photograph by Prof. C. F. Nachtrieb, of the Department of Animal Biology, in the United States of America, who lent the picture to *Insect Life*, the excellent journal published by the entomological division of the United States Department of Agriculture, in January, 1893 (vol. v., p. 206). This butterfly is larger than any species native to our islands, so an idea may be gathered of the appearance of the branch as seen by Prof. Nachtrieb. Being in color yellowish orgnge, with black veins, these roosting butterflies would have the appearance, when seen at a distance, of withered leaves attached to a dead branch.

Without becoming speculative as to how far the power of reason, as apart from instinct, guides, we cannot fail to see how important for the preservation of butterflies is the selection of suitable roosting places during the helpless period of sleeping. — *Science Gossip.*

## NANSEN'S EXPEDITION TO THE NORTH POLE.

The remarkably brisk rivalry that has lately developed in the field of polar exploration gives ground for the hope that during the next few years many Arctic discoveries may be made which will be of great importance to science, so that in the near future the map of the North Polar regions will present quite a different picture from that with which we are familiar. The methods employed for conducting such expeditions, to say nothing of the latest scientific discoveries—such as electric light and the phonograph—that lend their aid, have opened a new era in polar explorations. The most notable ones, as far as the expeditions themselves are concerned, which will try to reach the North Pole from many different directions, are the following: The Norwegian expedition of Dr. Fridtjof Nansen, who hopes to reach his goal from the island of New Siberia; the North American expedition of Lieut. Peary, who will push to the north by way of Greenland; and the expedition of the Englishman, Fred. Jackson, who will take Franz Josephsland as the starting point. Besides these, an expedition consisting of eight persons will be sent out from America, for the purpose of exploring unknown Arctic regions. This party, which will be conducted by a German connected with the geological survey of the United States, Robert Stein by name, will go north along the western coast of Grinnell Land, because those who are supposed to know about such matters claim that the best route to the extreme north is along a stretch of western coast which extends to the pole. In connection with polar explorers we may mention the Norwegian, Martin Eckroll, a wealthy merchant of Lofoton, who is greatly interested in Arctic expeditions, and has a theory that a so called sledge boat, drawn by a number of dogs, could go over the ice from Spitzenbergen to Franz Josephsland, and from there over the North Pole to the eastern coast of Greenland.



ANOSIA PLEXIPPUS, ROOSTING.

The polar expeditions mentioned, with the exception of the first two, will start next year. The Peary expedition, consisting of ten persons, started last summer, in the sealing boat Falcon, for Whale Sound, in the northern part of the western coast of Greenland, where the expedition will winter. In the spring the expedition will start by the route followed by the former Peary expedition over the inland ice to Independence Bay—shown in the accompanying map—and when this point is reached, they will divide into groups, one of which will be led northward by Lieut. Peary, while another will explore the unknown coast from In-

dependence Bay to Cape Bismarck, a stretch of about 300 English miles. At certain places on this coast line land has already been seen from the ocean.

But no expedition has caused so much discussion, or met with so much opposition, as that of the Norwegian, Fridtjof Nansen, who started from Norway in his vessel, the Fram, and went along the northern coast of Siberia, following Nordenskjold's route, and steering toward New Siberia Islands. He expected to turn north from this group of islands and push as far forward in the ice as possible, and then leave the rest to those currents in the existence of which he firmly believes, having based his entire plan on them. The point to which Nansen will push forward lies near the place where the Jeannette sank. Some articles left on the ice by the sailors were found, after many years, on the southwestern coast of Greenland, a circumstance that plays an important part in Nansen's theory that there is an oceanic current leading over the North Pole. This theory, and his idea of allowing himself to be carried over the North Pole by the ice, have caused much head shaking and sharp criticism in expert circles. The well known American Arctic explorer, Gen. A. W. Greely, speaks of it with especial severity, saying that it is impracticable, unwise, and almost equivalent to committing suicide to try to carry out Nansen's plan of drifting with the ice pack. A similar opinion has been expressed in English circles. But the existence of the currents counted on by Nansen has not been absolutely proved, and therefore, it is useless to discuss the practicability or impracticability of the plan. Nansen is a man to whom danger is of no importance as long as there is a chance of carrying out his project. He has doubtless understood the great risk that he runs, and it must be said in his favor that he has done all in his power to secure the safety of those who accompany him. Not the least important of the steps taken with this object in view is the peculiar construction of the vessel, especial attention being given to the fact that she would have a hard fight with polar ice, and an attempt being made to solve the problem of providing a vessel capable of

MAP OF THE NANSEN EXPEDITION.

resisting the crushing action of the mass of ice in the polar sea. The solution of this problem will be of the greatest importance to future expeditions. and on it, in connection with the special conditions, depends the success of Nansen's undertaking, which is of a purely scientific nature. However, the importance of the result cannot be calculated until after the material has been collected and worked up, and, therefore, the question must remain in the background for the present; but it must not be forgotten that the sciences in the service of which Nansen has gone touch closely on practical life. Of course, the expedition will make very important discoveries in relation to the ocean currents, and a knowledge of all the conditions of the currents in the seas toward which Nansen is turning his helm is necessary for a better understanding of the laws connected with them.

For the rest, the tasks before this expedition are the same as those planned by Nordenskjold in 1877. Among these geology holds first place, for, from all appearances, the Nansen expedition will strike new lands which will probably yield rich fields for geological exploration. The different explorers have theories as to what is to be found at the North Pole, and they prophesy that Nansen's vessel will be held there for years. The expedition will also find a fine opportunity for meteorological investigation, the icy sea north of Siberia and the islands therein offering a rich field for that study. For the sake of the meteorology of Europe it is, as Nordenskjold showed, of the greatest importance to have reliable information in regard to the divisions of land, and the conditions of ice, air pressure and temperature in each of those parts of our earth about which so little is known. This is such an extensive field that the scientific men on the Fram can be occupied with it for years. As the vessel will pass through parts of the ocean that are rich in animal life, there will be an excellent opportunity for much interesting work in this branch of study, as well as for the study of botany on new lands that may be discovered. There is very little chance of finding human beings in any of these undiscovered countries.

At any rate, the expedition of Dr. Nansen, which is unusually well equipped for scientific work, will have rare opportunities for making a success of the undertaking, even if Nansen should not be able to make exactly the voyage planned and laid out on the charts. Provided with provisions for five years, and a stronger vessel than has ever before started for the Arctic regions, this party of explorers can look forward confidently to accomplishing great things. The dangers of the Polar Sea have scarcely any terrors for Nansen and the men with him.—*Ueber Land und Meer.*

[From the National Geographic Magazine.]

## SHAWANGUNK MOUNTAIN.*

By N. H. Darton, United States Geological Survey.

Shawungunk† mountain is a prominent range lying between Hudson river and the southern Catskills, in Ulster county, New York. To the eastward it rises from the Wallkill valley in steep inclines, surmounted by a high escarpment; to the westward it slopes to the Rondout valley. Along its axis it rises gradually south of Rosendale, and finally attains an elevation of 2,200 feet and a width of five miles. It continues to the southward, with somewhat decreased height and width, through New Jersey and Pennsylvania, where it is known as Kittatinny mountain, and gives rise to the Delaware, Lehigh and Susquehanna water gaps.

The well known summer resorts of Lake Mohonk and Lake Minnewaska are on the summit of Shawangunk mountain, in Ulster county, so that the region has become familiar to a large number of visitors. Unfortunately, however, no description of its geology has ever been published, and the meager references in the report of Mather‡ throw but little light on the subject.

During the autumns of the past two years I have had occasion to spend a few days on the mountain to determine the salient features of its geology in Ulster county, and they were found to be of great interest. In this article there is presented a brief summary of the results of my observations, but in a report on the geology of Ulster county, now in preparation, there will be a somewhat more detailed description of the region.

The structure of Shawangunk mountain, in Ulster county, is a particularly interesting illustration of close relation of rock texture to topography, for the presence of the mountain and its form are directly dependent on the structure of a relatively thin sheet of hard rock. In the accompanying illustrations an attempt has been made to represent its physiographic character, and the structure is shown in the cross section at the ends of blocks into which the supposed model is divided. The mountain consists of a widely extended sheet of Shawangunk grit lying on soft Hudson shales. This sheet lies in a gently westward dipping monocline, which is corrugated by a series of gentle longitudinal flexures. To the westward it dips beneath shales and limestones of the succeeding formations in the Rondout valley; to the eastward it terminates in long lines of high precipices which surmount steep slopes of Hudson shales. Its anticlinals give rise to high ridges and wide plateaus; its synclinals constitute in greater part the intervening depressions. In several portions of the mountain the grit has been eroded off the crests of the anticlinals and the underlying slates are bared. This is the case in a wide area southeast of Ellenville, in a long strip extending from near Lake Mohonk nearly to Rosendale, in a small area east of Wawarsing, and in the top of the mountain north of Lake Minnewaska. Mather has suggested that the great cliffs of the region are due to faults, but I find this is not the case. Only one fault was found, and this was a small overthrust in the Rosendale region. There are many slight faults of a few inches or feet, but they appear to be entirely in the grit.

The surface of Shawangunk mountain is nearly everywhere very rugged, and cliffs and rocky slopes abound. These consist of snow-white grits, more or less mantled with dark lichens, and are remarkably picturesque. There are many cataracts, several beautiful rock-bound lakes and widely extended views of the Catskills to the westward and the Hudson valley to the eastward. The ruggedness is due to the exceptional hardness of the grits, the softness of the underlying shales and a tendency to vertical jointing which gives rise to cliffs and clefts. There are low lines of cliffs all over the surface of the mountain, especially to the southward, but along the eastern face, where the grit is being continually undermined by erosion of the slate, they are of great prominence, in some cases having a nearly vertical height of two hundred feet and extending continuously for many miles. The "points" are projections or promontories of the eastern edge of the grit beyond the general crest line, due to a less degree of recession. Buntico point, Paltz point, Gertrude nose and Sams point are the most prominent of these, but there are many others of minor importance. The cliffs on the surface of the ranges are of various heights and lengths and rise along joint cracks. They face in various directions, but a north and south trend is predominant. They are usually in irregular, discontinuous steps on the slopes and face each other and inclose depressions of various sizes on the plateaus.

The lakes for which the mountain is famous lie in basins of moderate depth and are all near the top of the range. They are nearly surrounded by cliffs of Shawangunk grit of greater or less height, which add greatly to their beauty. The grit is mainly a massive white or gray quartzite or conglomerate, averaging 250 to 300 feet thick. The proportion of pebbles is large but variable, many beds being fine. The pebbles and grains are quartz and the matrix is siliceous. The conglomerate is the famous Esopus millstone, and has been largely quarried for two centuries.

The relations of the Shawangunk grit to the Hudson shale in the Shawangunk mountain region is one of slight but persistent unconformity. The coarse grit lies directly on the eroded surface of the shales. This erosion has truncated low arches of the slate, but has channeled its surface only slightly. Exposures of the relations are everywhere abundant. One of the best instances is along the road from Minnewaska to New Paltz, two miles south of Lake Mohonk. Here along the mountain slope a very low arch of the grit is seen surmounting a truncated arch of shales of materially steeper dip. Diversity of dip is seen at every locality, varying from very slight to 10°, but several points were observed where it was hardly perceptible.

The corrugations in the general monocline of the mountain are a series of anticlinals and synclinals which traverse the range diagonally from north-northeast to south-southwest, and begin in succession from northeast to southwest, their axes rising gradually to the southward. Beginning at the northern end of the range, the principal feature is the anticlinal which brings up the cement between Rosendale and Whiteport. South of Rondout creek, opposite Rosendale, the upward pitch of this flexure increases rapidly, and the Shawangunk grit soon rises into a ridge of considerable altitude. In a short distance from the creek the grits are eroded from the crown of the arch, and to the southward the underlying shales constitute a series of high but rounded hills extending along the center of the mountain.

The occurrence of these high hills of soft rock is a striking feature, and they give a unique character to this portion of the mountain. Their presence is due to the former protection of the arch of Shawangunk grit by which they were originally covered. The grit in the flanks of this arch extends down the slopes of the mountain, where it dips beneath overlying formations in the valley on the western side and extends nearly or quite to the base on the eastern side. One mile and a half south of Rosendale the range has the structure shown in the first section of the illustration. It will be seen that the sheet of grit lying along the eastern slope of the mountain is considerably corrugated. This corrugation consists in the main of a western limb dipping more or less steeply eastward and a shallow synclinal. In one portion of the ridge there is a very abrupt anticlinal crumple in this synclinal which extends but a short distance in either direction and then flattens out into the general flexure. There is also a fault which extends from the Rosendale cement region. It gives rise to a sharp ridge which continues to the first road across the mountain, beyond which it dies out. Along the eastern face of the northeastern range of the mountain the dips are in greater part gently to the westward. Along the railroad they are 20°, and this is the average for some distance. On the first road across the mountain the dips are 60°, but this steep dip soon gives place to inclinations of not over 10°, and toward the southern end of the ridge the synclinal dies out, leaving a gentle dip eastward. This grit area lying along the eastern slope of the mountain terminates abruptly southward in a fine line of cliffs, which, owing to the upward pitch of the bed in this direction, are of great elevation. This is Buntico point, one of the most prominent topographic features in the region.

South of Buntico point the eastern crest and summit of Shawangunk mountain consists of a great mass of Hudson shales, which are being rapidly and deeply eroded. They extend southward nearly to Lake Mohonk, where the crest of the anticlinal is occupied by grit for some distance. The grit in the western limb of the anticlinal on the northern end of the mountain lies part way down the western slope and does not attain the prominence that it has in the area terminating in Buntico point. It constitutes a monoclinal ridge, with a line of cliffs along its eastern edge, above which the hills of Hudson shales rise several hundred feet. To the westward the Shawangunk grit dips beneath overlying formations in the synclinal valley of Coxingkill. On the opposite side of this valley, at High falls, there rises one of the principal anticlinals of Shawangunk mountain, which soon brings up Shawangunk grit in the low ridge on which the village is built. This ridge gradually increases in width and altitude southward, and near the line of the third section on the illustration its crest is nearly as high as the ridge eastward, from which it is separated by the synclinal valley of the Coxingkill.

South of Alligerville the mountain widens rapidly as flexure after flexure brings up the Shawangunk grit from the northwestward. The western ridge rises gradually on the upward pitch of the axis of the flexure and finally becomes the highest part of the mountain east of Ellenville. Southwest of Lake Mohonk there are five of these flexures, together with various small undulations, with a creek in each synclinal. Lake Minnewaska is in the crown of the anticlinal which rises at High falls, and Lake Awosting is on the western slope of the same flexure.

These lakes are all situatedn ear the eastern side of the mountain and about 150 feet below the crest. They are similar in relation and originated under almost the same conditions. Lake Mohonk occupies a north-and-south cleft in the crown of the anticlinal which rises at Rosendale. The structure of Lake Mohonk is shown in Fig. 1.

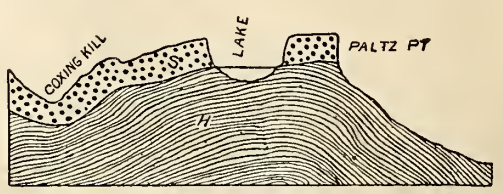



Fig. 1.—Cross Section of eastern Ridges of Shawangunk Mountain through Lake Mohonk, looking northward (S, Shawangunk grit; H, Hudson shale). Vertical scale exaggerated.

The lake basin is in Hudson shales, but it is bordered on the east and west by high cliffs of Shawangunk grit. To the south there is a gap in the front of the mountain through which the shales extend to the lake. The top of these shales is a few feet above the surface of the lake at its southeastern end, but the pitch carries them a few feet below the water surface toward the north and west.

This view is looking to the southward and out of the gap in the eastern front of the mountain through which the Hudson shales extend to the lake. On the left is Paltz point, and to the right, in the distance, is Cope point, a projection of the southern extension of the eastern front of the mountain.

East of the lake there is a thick mass of grit, which lies along the crest of the anticlinal. It begins a short distance northward and is terminated by very abrupt cliffs in Paltz point, near the southern end of the lake.

At the head of the lake and the base of the southern end of the mass of grit in Paltz point the Hudson shales constitute a small plateau which surmounts the long eastern slope of the mountain. There is no cross drainage way at the base of the cliffs, and the reason for the abrupt termination of this point is obscure.

The grit dips gently west-northwestward along the western side of Paltz point and very slightly eastward in its easternmost part. Northeast of the lake the dip is at a low angle to the westward, but there are several slight undulations. There is everywhere a pronounced pitch northwestward. Owing to the westerly dip the grits in the Paltz point ridge are somewhat lower just north of the lake than elsewhere. It will be seen from these statements that the lake lies slightly west of the center of the arch of the anticlinal, and all the dips along its shores are northwestward, although at very low angles. The degree of dip rapidly increases down the western slope of the mountain into the synclinal valley of Coxingkill.

The outlet of Lake Mohonk is to the northward by a branch of Coxingkill. This branch flows through a slight depression separating the Paltz point range from the main mountain mass, and then obliquely down the flank of the anticlinal.

South of Paltz point the eastern front of the mountain presents a nearly unbroken line of high cliffs for many miles along or near the crest of the anticline.

Two miles south of Lake Mohonk there is a slight depression in the crest line through which the road to Lake Minnewaska passes, and there are several other depressions of less amount. Millbrook mountain is the culminating feature of this portion of the range, beyond which its front is somewhat more irregular in contour.

Lake Minnewaska is similar to Lake Mohonk in appearance, but it is somewhat larger. It was not ascertained whether its basin extends into the Hudson shales, for there is a continuous rim of grit surrounding it. As a very great thickness of grit is exposed above the water level in this vicinity, it seems probable that the bottom of the lake is in or very near the shales. This probability is increased somewhat by the presence of

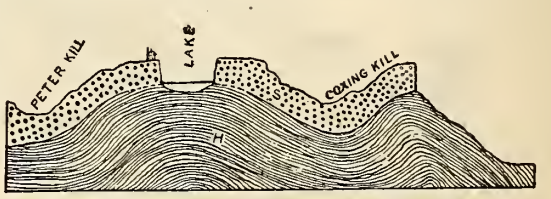



Fig. 2.—Cross Section of the eastern Ridges of Shawangunk Mountain through Lake Minnewaska, looking northward (S, Shawangunk grit; H, Hudson shale).

the steep cliffs and the width of the valley or cleft in which the lake lies. In Fig. 2 there are shown the principal structural features at this locality.

The cliffs which extend along the eastern side of the lake are very high and precipitous. As at Lake Mohonk the rocks are greatly fissured and are traversed by many deep, wide clefts. The dips are gently anticlinal about the lake, which is on the axis of the flexure, but they increase in amount to the east and west. The lake empties to the southward through a wide gap into the synclinal valley of the Coxingkill, and it may be regarded as the head waters of this stream.

A mile northeast of the lake the anticlinal on which the lake is situated is crossed by the road to Port Hixon, and in the vicinity of the road the grit has been removed from the crown of the arch for some distance. The road crosses the ridge in a gap on the Hudson shales, and the edges of the grit give rise to high cliffs on either side. Down the slope aways the grit outcrops on the flank of the arch, but the slate extends along the upper slopes of the mountain for some dis-

* Published by permission of Prof. James Hall, State Geologist, in advance of the Annual Report of the Geological Survey of New York.

† Pronounced "Shongum," according to the residents of the region.

‡ Geology of New York: Report on the First Geological District, 1843.

tance, especially on the east side. The occurrence of the slate in this inlying area is a very striking feature, and the reason for the removal of the grit at this locality is not clear.

South of Lake Minnewaska the front of the ridge trends southwestward some distance and the Coxingkill anticlinal and the anticlinal next west pass out to the south. There is a prominent "point" in this vicinity known as Gertrude nose, which is due to a deep incision in the front of the mountain made by a small branch of the Wallkill. This stream heads on the plateau south of the lake, passes over the edge of the grit in a series of falls, and has cut a deep gorge into the Hudson shales below.

Lake Awosting is the largest lake of the series, and has a length of about a mile. It is surrounded in greater part by low cliffs and rocky slopes, but near its eastern end there is a line of very high cliffs which extends in from the crest of the mountain eastward and constitutes a high, west sloping plateau northeast of

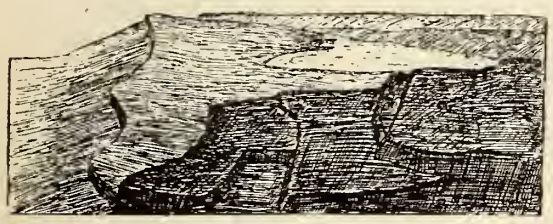


FIG. 3.—Lake Awosting from the East-northeast, Sams Point in the Distance.

the lake. In Fig. 3 there is given a view of this lake based on kodak photographs.

The basin of the lake does not appear to be in Hudson shales, although possibly they underlie its deeper portions. The grit dips gently westward along the lake, and this dip continues over a wide area of surrounding region. On the west there is a long slope to the main Peterkill valley, which extends from a low cliff along the lake. The outlet of the lake is by a fork of the Peterkill, which flows along the west sloping grits for half a mile, and then in high falls over the grit into the kill. East of the confluence there is a narrow depression known as Dark hole, which extends southeastward up the slope of the mountain. It is rimmed by moderately high cliffs of west dipping grit and was cut by a stream which empties into the Peterkill. On the southern side of Dark hole is the high plateau of which the eastern front constitutes the cliffs at the southeastern end of Lake Awosting.

The Peterkill valley from beginning to end extends along the western flank of the anticlinal on which Lake Minnewaska is situated, and has a cliff of west dipping grit on its western side and slopes of grit on its eastern side. Four miles below Lake Awosting the kill passes over Awosting falls and then over a series of cascades, aggregating in all a fall of over 240 feet approximately. In Awosting falls there is a clear fall of 60 odd feet. They are a mile north of Lake Minnewaska. In the gorge below the several falls there are high cliffs of grit for some distance, but owing to considerable pitch northward or down stream and a thickness of grit somewhat over 200 feet, the kill has not cut through to the Hudson shales.

South of Lake Awosting there are two small, shallow ponds on the summit of the mountain. Mud pond, at the head of Fly brook, the principal fork of the Peterkill, is one, and Lake Maratanza is the other. Lake Maratanza empties eastward by a branch of the Wallkill, which pitches over the edge of the grit on the crest of the mountain, in a great fall into a deep gulf of Hudson shales. The locality is known as Verkeerder falls.

Between Gertrude nose and Sams point the crest of the mountain is very high, but for some distance the edge of the grit is broken into great terraces, and there is a sloping bench of Hudson shales of some width at the base. Several branches of Wallkill drainage head in the crest of the mountain in this region and pass over the edge of the grit in falls of which the above mentioned Verkeerder falls are the most noteworthy.

In this region the mountain narrows and some of the flexures pass out to the southward. This narrowing is due to recession of the edge of the sheet of the Shawangunk grit, which is closely related to the upward pitch of the flexures. This pitch increases the height of the mountain southward, but with increased height there is a corresponding increase of erosion in the soft underlying shales, which, beyond certain limits, causes rapid recession. This is illustrated by Sams point, where the maximum altitude of 2,240 feet is attained. The "point" is a narrowing extension of the grit along the axis of a very flat synclinal, which finally terminates in a high narrow cliff presented southward. From the wide anticlinal area to the west the grit has been eroded, and the Hudson shales occupy the surface in a group of very high hills. These hills are surrounded by cliffs of the grit, which on the eastern side, rise somewhat above their summits, on the northern are about even with their higher summuits, and on the western lie along their flanks. Originally the grit area in this region and southward was as wide as it is now at Lake Mohonk, but, owing to the greater height to which the northern pitch of the flexures carried the grit, it was here more rapidly and widely undermined and removed. It is the grit on the western limb of the anticlinal that lies on the western flanks of the shale hills, constituting a monoclinal ridge of considerable prominence, which extends from Ellenville far southward into Pennsylvania. This monoclinal mountain consists of a single-crested ridge of the Shawangunk grit, with a long slope up the dip from the valley westward, which terminates in an east-facing cliff of grit surmounting long rolling slopes of shale on the eastern side of the mountain.

Its structure near the southern edge of Ulster county is shown in the illustrations, and this is typical for the greater part of its course. In the valley westward there is a succession of formations overlying the grit. They are the Clinton red shales, Salina water lime, Helderberg limestone, Oriskany sandstone, Esopus shales, Onondaga limestones and a great mass of Devonian shales and sandstones which extend into the Catskills. The dips along the western slope of the mountain are low north of Wawarsing, but they rapidly increase southward to an average of about 60° in the vicinity of Ellenville. In this region of steep dips the streams flowing down the steep western slope have cut deep gorges, which extend through the grit into the underlying shales. The two streams south of Ellenville are exaggerated examples of this, and they have been largely instrumental in baring the Hudson shales on the anticlinal area behind Sams point. The two streams just north of Ellenville also cut into the shales, but they are very small and have only formed narrow gorges. Opposite Napanoch is a small creek which has cut a deep gorge into the shales, and in the higher part of the slope has bared the grit from an area of considerable size, which is surrounded by high cliffs. The stream opposite Wawarsing has cut a gorge and removed an area of the grit on the upper slopes of the mountain, but does not cut through to the shale. The head of this depression extends into the head of the depression opposite Napanoch, and both are surmounted on the east by a continuous line of high cliffs. The stream which flows out of the mountain at Port Hixon is larger than the others and has cut a deep, wide gorge; but owing to the lower dip of the grit, it does not appear to have cut through to the shales to any great extent. No shales were observed in place in the depression, but a small amount of shale debris was noticed at one point. Everywhere along the steep slopes there are clefts in the grit, some of which appear to extend down to the shales. One of these is the "Ice cave," a locality which is widely famous in the region. It is high in the slope, about two miles east-northeast of Ellenville. Ice and snow remain in it in greater or less amount, and in some seasons they are preserved entirely through the summer and autumn. In the vicinity there is also an old copper mine from which large supplies of fine quartz crystals were obtained some years ago. The top of the mountain southwest of Wawarsing is a wide plateau, which is traversed by the valley of Stony creek. Its surface is very irregular and low cliffs of the bare grit abound.

The grit in the higher portion of Shawangunk mountain nearly everywhere presents a basined surface. These basins are depressed an inch or two below the general level and are of various sizes and shapes. They usually contain pools of water and some sand and pebble detritus. They are mostly smooth and even polished and are distributed all over the mountain, but particularly on the western slope. With the polishing are associated lines of glacial scorings and striation, which are conspicuous at nearly every locality. Julien* has recorded the direction of some of these striæ and scorings. The general direction is southwestward and the average depth is between one-sixteenth and one-eighth of an inch. In the vicinity of Sams point the most abundant scratches trend south 46° west and south 29° west. A few were observed somewhat more to the westward in direction, one-fourth inch in depth.

In the vicinity of Lake Mohonk, about the hotel and on the northwestern slope, south 10° west is the general direction; on the southeastern side of the mountain and on the road to Alligerville, it is south 40° east, and at Sky top, south 18° east. At Lake Minnewaska the trend is south 10° west. There is but little foreign glacial drift on the summit of the range, so far as observed, but there is considerable in the adjoining valleys.

The origin and history of the lakes are not entirely clear, but they appear to be due to glacial agencies. The principal feature has been a local deepening and widening of a pre-existent valley, aided, at least in the case of Lake Mohouk, by the presence of shales at the point now occupied by the lake. They do not appear to be due in great measure to damming by glacial or other debris or to dislocation.

Owing to its prominence the mountain has been long exposed to erosion. Originally the grit was overlain by a great mass of limestones and shales and the rocks of the Catskills, but these were removed far down into the Rondout valley at an early period. During the glacial epoch there was great erosion and the removal of great masses of the grit, which is now found in drift far to the southward. To the glaciation, too, probably is due the abruptness of Paltz point and other features of that sort. The grit also originally extended far to the eastward, but, owing to long continued undermining by the removal of the soft, underlying shales, its front has receded to its present position. This recession is still actively in progress, and every year there fall great masses from the front of the mountain. One of the regions of weakness is Paltz point, for its base is exposed to erosion on several sides, and it will eventually disappear. Probably before it is gone the streams heading near its southern end will cut back through the shales at the head of Lake Mohonk, and this beautiful body of water will be tapped. Of course, this is all very remote, so far as human history goes, and artificial means will stay its progress in some measure, but it will all be accomplished in the near future, geologically speaking. Lakes Minnewaska and Awosting lie so far back from the front of the mountain that they will survive Lake Mohonk by a very long time.

## HINTS ON THE ART OF LANDSCAPE GARDENING.†

By THOMAS HAWKES, Member of Illinois Chapter, American Institute of Architects.

LANDSCAPE gardening is an art, and he who in its practice accomplishes the best results is the one who keeps closest to nature, develops all its possibilities and applies his art to nature in such a way that the art is not manifest. All designs should conform to the laws of nature. If they do not they never can be truly artistic. The work of the landscape gardener must necessarily include so much accurate knowledge of architecture, engineering and gardening of itself, that no mere novice can possibly attempt it with any beneficial results. The marvelous work of transforming the dreary sand dunes of Jackson Park into the wondrously beautiful World's Fair grounds was indicative of this, and the possibilities of aiding nature, by an art so complete as to be hardly visible, were illustrated then, in a way that was a liberal education to many millions of people and advanced the general ideas regarding landscape gardening in a way not possible by scores of years of teachers, books, or instruction.

The planting of our parks and gardens should have a great amount of consideration, and we should have a diversified vegetation, with an admixture of deciduous and evergreen trees, varied, too, from the native trees with regard to their suitability to the climate, so avoiding formality. The grounds can be improved from year to year with such permanent planting as can be afforded, instead of making a uniform mediocre effect.

Trees should be planted for a definite purpose; they are too ofteu put in without due consideration, and sometimes with the effect *of hiding* desirable views. This illustrates the purpose they can fill of hiding objectionable ones, and sometimes by natural mounding and then planting, they effect this purpose better than high walls or fences. Trees planted in groups are effective in extensive grounds and give "distance." Those who have seen grounds where evergreens have been planted out at equal spaces over a large area of park-like land have doubtless been reminded of the childish use they made of the trees contained in their Noah arks. As a rule the custom prevails of planting trees too closely together; that, indeed, is *literally* imitating nature, for in mauy of our forests the trees crowd each other so closely that in the struggle for existence they starve, make only a puny growth, and ultimately die from a lack of a proper amount of light, air, and root nourishment. In trimming out forest trees, it has been my experience that it is as well to proceed cautiously at first, and remove only those which are injuring the growth of others, leaving the ones which promise a vigorous life. I have had the satisfaction of seeing the remaining trees make fresh wood, and grow with redoubled vigor. On a poor soil, with a dense growth of trees, it is unwise to give too much light and air at first.

As large masses of trees prevent the free circulation of air, it is as well in improving forest land to open some vistas, and give *lungs* to the woods, before thinning out too much. In doing this an opportunity is afforded to create park-like effects.

It is an objectionable practice to clip trees and top them; it certainly spoils their beauty, and in some cases the mutilation causes decay. If it is an objection to have trees with stately heads, because they take up too much light and space, do not plant that kind.

The general custom of selecting trees of a large growth for transplanting, so as to get an immediate effect, is characteristic of the spirit of the nation, but I have observed that younger trees thrive better, and in a few years catch up with, and surpass in beauty, those that were more mature at the time of planting. The younger trees are not so liable to die from replanting.

The time of transplanting varies in different climates. I consider generally that the fall of the year is the best time, when the sap has ceased to flow, while the earth is yet warm, and the consequent shock of removal is not so great as in the spring. The temperature of the earth is then much lower than the atmosphere and the roots are chilled while the stem and branches are being warmed. The practice of removing trees and plants while the earth is frozen around the roots has much to commend it, if the roots are protected from injury; but it is not sufficient to dig a hole of the size required to receive the small ball of earth around the roots of the tree to be planted. A much larger excavation should be made for this purpose, in uncongenial soils, with a layer of broken bricks aud mortar rubbish placed in the bottom, and filled in with prepared soil of decayed sod or other material as the locality demands. This will insure a vigorous growth of the tree.

In making a new lawn, where there is any irregular filling, the ground should be well tamped, or soaked with water and rolled, to prevent future unequal settling, which is a frequent cause of annoyance. There should be a liberal depth of good soil to retain moisture for the roots of grass during the hot weather, though in some localities too much soil is objectionable, as it causes a rank growth, which requires constant mowing.

In refractory ground it is sometimes necessary to break up the hard pan of the existing surface before putting on the soil, and in heavy, wet clay ground it may be necessary to have tile drain subsoil, as well as surface drainage. The excavation for these drains can be filled in with either gravel, broken bricks, stone or other debris, to within a foot of the surface, and then covered with soil. A lawn that otherwise would be unfit for walking upon after heavy and continuous rains can thus speedily be made dry. Wet ground often produces moss to the detriment of the grass.

The lawn can be beautified by planting, by one who understands it, and knows what growth the various plants and trees will make, and what will be their effect in contrast, shape and color. For instance, a great variety can be produced by the planting of evergreens among deciduous trees, and the grouping of hardy foliage plants, and the display of rare, flowering and interesting shrubs and specimen trees, and the planting of high grasses, trailing roses and creepers, vines trained on trees, etc., will give a hint as to the manner in which this can be done. A judicious selection of plants is required, and artistically set out a pleasing effect is secured, that gives a constant variety, with planting that will need but little care. Where shrubs are not obtainable, or in districts where they will not live without protection, many of the hardy native trees can be used for the purpose, and if kept closely cut down, they will form a dwarf growth, and have a shrub-like effect.

Geometric flower beds for the display of masses of flowers, without the setting of green that nature always gives, have an unnatural effect and should be avoided in pure design. Large masses of the same variety of flowers are sensational and unsatisfactory, and do no service, except it be to show the producing power and skill of the horticulturist. Where it is done in formal beds, in such positions as formal beds are allowable, the flowers should be relieved by foliage plants, as nature shows us in all her flower displays.

Walks must of necessity be made of different materials in different districts. No rule can be laid down for their construction, except that, in my opinion, they should never be made of dark finished asphalt, as the

* New York Academy of Sciences, Trans., vol. iii., pp. 22–29.

† Abstract from an interesting pamphlet on the subject. Published by J. C. Winship & Co., Chicago, 1894.

color contrasts badly with the grass. Cement concrete is also objectionable, because it *looks* hard and unnatural, and the edges are preternaturally true. A good binding gravel (or crushed stone or granite) walk, with proper foundations, is to my mind the ideal walk for a garden; its color harmonizes, it is easily weeded, regulated, rolled and kept in order; it gives the gardener a chance to make a nice edge to his turf, and when properly drained is soon dry after rain. If there is any gravel in the neighborhood, it can generally be made of the right consistency by admixture.

The line of a road should be carefully considered with regard to the scenery, the trees, and the views of the buildings to be reached, so as to create favorable impressions of the whole. The architectural effects of fine buildings have often been marred by neglect of proper consideration in this matter.

The roads for a public park should be wide according to their use, but they should be made subordinate to the park. If they fill their purpose of allowing one to drive around and through the grounds, so as to command the principal points of interest, and the views, conduct to the buildings, are gracefully curved and follow the contour of the ground, they must of necessity be in the right place.

Cutting up a park with a labyrinth of roads not only robs it of its park-like nature (a park requiring broad open spaces with long vistas), but takes away just so much of its area of grass and foliage. The roads, in showing the beauties of the park, should add to them by their graceful outline, but it is in the conformation of the ground, the trees, the planting, and the water effects, that we seek for real enjoyment.

It is only from experience that one can speak with any authority on the subject of practical road making. Having designed and executed many miles of roadway in dissimilar formations of country with varying materials, I speak from my own knowledge and experience of their construction and maintenance.

There are several systems of metaling roads used and advocated, but each case should be governed by circumstances.

I am here referring only to country roads and carriage ways for light traffic, made of the material most readily accessible and cheaply obtained, and will mention the principal things that are necessary to be observed in making a good roadway.

Assuming always that the right route is chosen, the grades are not objectionable, the width is sufficient and of right proportion, the roadbed should be formed to as true a surface and contour as the top metaling has to be, and made hard and compact. It costs no more than to do it carelessly, and insures the application of an equal thickness of wearing material, and a road made in this way with a thin layer of metaling will wear better than a thicker layer placed on unprepared ground.

Where filling has been done it should be tamped or watered, to settle and consolidate it, and should be thoroughly well rolled. This is most important, for unless the roadbed is hard and perfectly true, the top surface cannot be so, without excessive rolling and making up. The expense of renewing the metaling caused by settlement gives more annoyance and costs more than it would to form the bed properly at first. It is a common practice to leave the roadbed rough and uneven, and level up with the top dressing, but this practice cannot be too strongly deprecated, for, as a general rule, little attention is given to roads when once they are made, and the inequalities that are soon apparent increase with the passage of every vehicle.

I have generally found that each neighborhood, and ofttimes the work itself, provides some, if not all, the necessary material for a road foundation; for instance, in a clay country the clay can usually be burned in heaps and used for that purpose. It makes an excellent dry and hard foundation, but is fitted only for that, as it grinds into red mud or dust if exposed to traffic, and either gravel or stone must be obtained for the top dressing.

In a country of stone formation the stone, perhaps obtained in excavation for work, or got close at hand, can be placed over the surface in slabs, cracked by sledge hammers to fit in position, the interstices can be filled in with spawls, and the top dressing made of suitable broken stones.

In a gravel district there should be no trouble, for while bank gravel can be used for the foundation, the gravel can be screened to obtain clear stones to be used for top dressing.

A judicious admixture of bank and clean lake gravel will make a good road.

Chalk for foundations and broken flints for top dressing is another combination that can be used. They are often found in the same locality.

Furnace slag or cinders make excellent dry foundations for roads and walks.

There are few localities, however, where improvements are made in which supplies of proper road making material cannot be obtained.

The foundation material must be evenly spread and leveled and rolled, and should be as true to contour as before mentioned for the roadbed, before applying the top dressing, which should be of material that will "pack" and wear well, and not get sticky in wet weather, or grind into dust. It should be well rolled and left compact and hard, and be of sufficient thickness to prevent the wheels from ever cutting through to the foundations. This latter should never be allowed to occur, and each rut as it appears should be carefully filled in. A new road is like a new baby, it requires to be carefully watched and nursed the first year of its life. The thickness of the metaling required varies with the use to which the road is to be put, and the nature of the subsoil, but it is not often that a sufficient foundation is made.

A most important part of maintaining roadways is proper drainage. The location, grade and use of road are important factors in determining the best treatment in this respect. The general principle, however, should be to give the road a sufficient contour—not exceeding one-half inch to the foot—so that the water will run freely to the sides, and flow into ditches, either open, or with tile drain or sewer pipes laid in them and covered over, with catch basins at intervals.

The old plan of the open ditch on each side, however modified, is the simple and natural way. In building roads in ravines where there is considerable flow of water after thaws and heavy falls of rain, I have found it the only practicable way of preventing wash-outs, which would certainly occur if a covered sewer and catch basin system was adopted. It does not necessarily follow that the ditch must be on both sides all the way; a smaller gutter can be formed on one side, crossing under the road to the larger one at intervals.

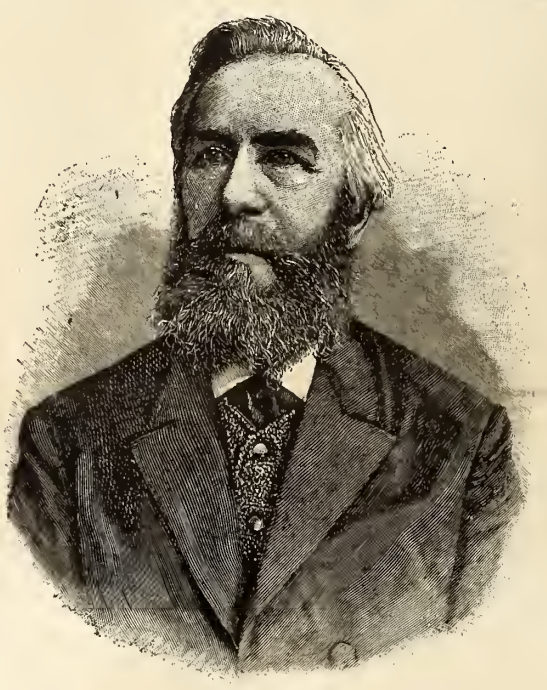
Grass drives can be made by putting in a proper foundation for the roadbed, draining it, and then soiling and sowing the surface, and they can be driven on after rain without cutting the sod to any extent. They are extensively used on large estates. They serve the purpose admirably for light occasional use, there is no cost for maintenance, and there is no road apparent to mar the landscape effects.

In wet and boggy places, I have frequently prepared a roadbed with the adjacent soil, formed on thick layers of brush, laid transversely, and then metaled in the usual manner, in this way making solid hard roads, over ground that was before impassable.

## ERNST HAECKEL.

February 16, 1894, completed the sixtieth year of the life of Ernst Haeckel, the German student and talented scientist, whose work as a pioneer has been equaled by few. He now occupies Oken's chair at Jena, and has inherited, so to speak, the old master's boldness of thought. He is one of the most zealous advocates of the Darwinian theory, and was, perhaps, the first professional man in Germany who declared for this doctrine.

He was born in 1834, in Potsdam, and studied medicine, and, in connection therewith, the natural sciences, in Wurzburg, Berlin and Vienna, and after he had completed his course he settled down in Berlin to practice his profession. But as Darwin's epoch-making works appeared one after the other, the young physician decided that his vocation lay in another direction. His studies carried him to Naples and Messina in 1859 and 1860, and in 1861 he went to Jena to teach zoology. He was called to the high school there in 1862 as an under professor, and in 1865 became a regular professor of this branch of study. He still remains true to his chair in Jena, but his teaching has sometimes been interrupted by extensive journeys. In his numerous literary works he addressed not only those who were interested in one branch of study, but all educated people (take, by way of example, his "Naturlichen Schopfungsgeschichte"—"The History of Creation"); and, furthermore, he explained his point of view in clear popular lectures delivered in almost all parts of Germany.



ERNST HAECKEL.

Although scarcely any of the modern students of natural science ranks higher as an investigator of exact details, he bases his theories less on these than on a combination of all that has been brought to light by recent research. Haeckel was, in fact, the first to point out the importance of speculative investigation in connection with the study of natural science, and to this he owes his uncommon success.

He has done much for the spread of the Darwinian theories, and has made many important corrections in them, and even those who disagree with Haeckel and consider that his ideas are hypothetical cannot deny that no similar attempt has ever been made to trace all life, animal and vegetable, back to a common origin. At present no other name is as widely associated with the theory of evolution as Haeckel's. The bold German scientist has gained many friends everywhere by his frank and open manner. The best that we can wish him is that he may long retain his present ability for thought and work; he has already done all that is necessary to make his name famous for many generations to come.

For the accompanying engraving we are indebted to the *Illustrirte Zeitung*.

The Whistling Tree.—A species of acacia, which grows very abundantly in Nubia and the Soudan, is also called the "whistling tree" by the natives. Its shoots are frequently, by the agency of the larvæ of insects, distorted in shape, and swollen into a globular bladder from one to two inches in diameter. After the insect has emerged from a circular hole in the side of this swelling, the opening, played upon by the wind, becomes a musical instrument, nearly equal in sound to a sweet-toned flute.

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[From Engineering.]

## ARMSTRONG QUICK-FIRING GUNS.

The famous firm of Elswick can with unquestionable justice claim to have taken the lead in the construction and design of quick-firing guns of large caliber, and has maintained its position in this important branch of artillery.

Important alterations or modifications have from time to time been introduced, so that the quick-firing guns of to-day differ materially in detail from those that were first produced in 1886. The modifications referred to have taken place in nearly every detail that goes to make up the complete gun and mounting; for instance, comparing the quick-firing gun originally designed with those now under manufacture, we find that the caliber of the guns has advanced from 4·7 in. to 6 in., or it may indeed be said (as will afterward be explained) to 12 in. The protecting shields, originally of 1¼ in., have now in some cases reached 6 in. in thickness, the shape of the shield being also modified to give better protection; and the breech mechanism has been improved so as to give a higher rate of fire.

With a charge of 12 lb. of pebble powder (ordinary black) a velocity of about 1,800 foot-seconds is obtained, giving to a projectile weighing 45 lb. an energy of 1,010 foot-tons. This velocity was considered very satisfactory a few years ago, but now appears low in comparison with the 2,100 foot-seconds obtained from the same gun with a charge of only 5½ lb. of cordite, and producing an energy of 1,375 foot-tons. Here a charge of cordite of less than half the weight of the ordinary powder charge develops 36 per cent. more energy. Again, taking the 6 in. quick-firing gun, the ordinary powder charge is 34 lb., which gives to a projectile weighing 100 lb. a velocity of about 1,970 foot-seconds, or an energy of 2,690 foot-tons; the cordite charge of 15 lb. develops a velocity of 2,200 foot-seconds, or an energy of 3,356 foot-tons, this being nearly 35 per cent. in excess of that due to the charge of ordinary powder.

In both the above cases the chamber pressures due to the cordite charges are lower than those produced by the ordinary powder charge, and it must not be forgotten that the mounting receives comparatively less strain; for the energy of recoil with the light charge of cordite would be less per foot-ton of energy of shot than it would be with the heavier charge of black powder.

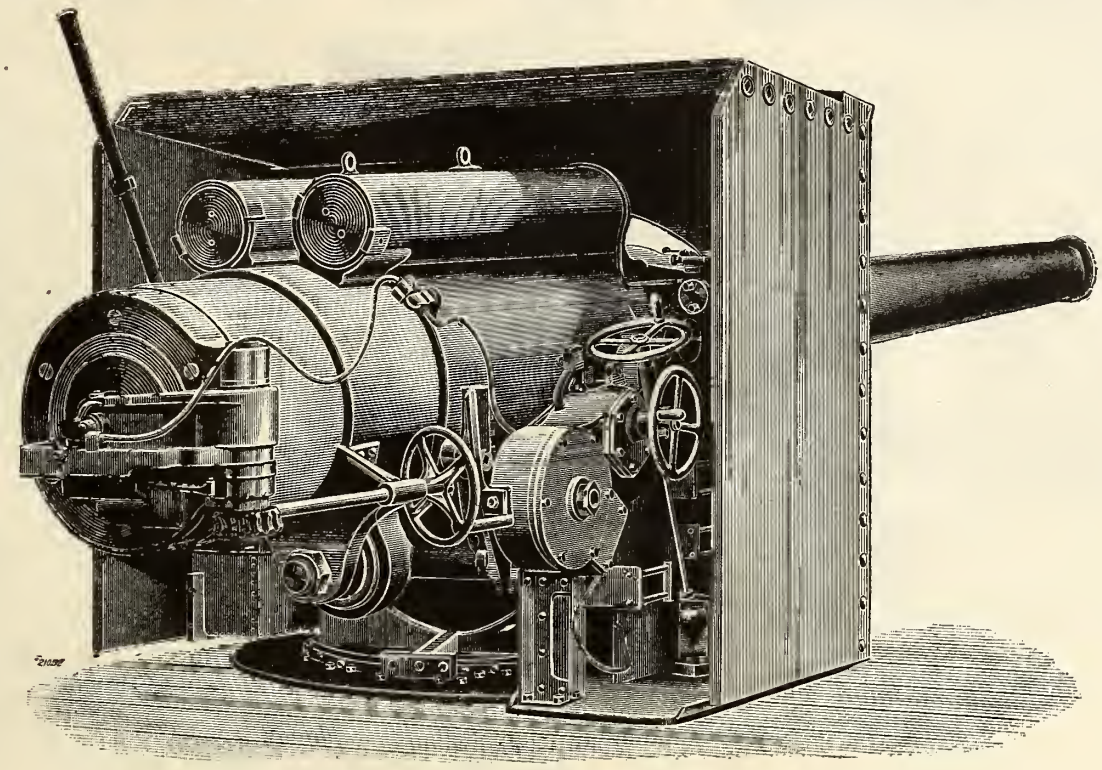
Cordite is so called because of its appearance. It is manufactured in lengths, having a circular section, the diameter of which varies from that of a very thin string for rifle caliber arms to that of a thick cord for the larger sizes of artillery. Its manufacture does not concern us at present; it will suffice to mention that cordite is a mixture of nitro-cellulose and nitro-glycerine, with a small admixture of mineral matter. All the experiments have shown very conclusively that cordite is one of the most satisfactory of all the different types of smokeless powders yet introduced.

We will now give a description of the Elswick modern quick-firing guns, explaining as we proceed the reasons for the modifications that have taken place in the original design. As the guns are all made on the same principle, it will be best to select the largest, the 6 in., as the typical one for description, and to commence with the breech arrangements, which are a specialty of the Elswick guns, and are perhaps the most important feature of quick-firing guns. The breech screw is on the principle of the interrupted screw, but the front portion is tapered, the rear portion being cylindrical. By this arrangement two advantages are secured—first, the action of opening and closing the breech is much simplified, as the withdrawal and bringing away of the breech screw can be done in one motion instead of two; and, secondly, the cone shape enables the screw not only to take hold of the inner surface of the breech hoop and jacket, but to distribute the engagement, and therefore the strain and support, over a much larger portion of the transverse section of the gun. The breech screw is further arranged so that the threads of the smaller or coned end correspond longitudinally with the interrupted or plain spaces of the larger or rear end, and *vice versa;* thus the strain is also distributed throughout the entire circumference of the breech screw, instead of, as formerly, half the circumference being lost by the interrupted spaces. The coned breech screw passes on to the central projection of the carrier from the front, and is prevented from coming off by a bolt. This bolt screws into the breech screw, and has a plain end fitting into a groove, which is cut in the carrier at the same pitch as the threads of the breech screw, and which is long enough to allow the bolt to be turned for screwing up the breech.

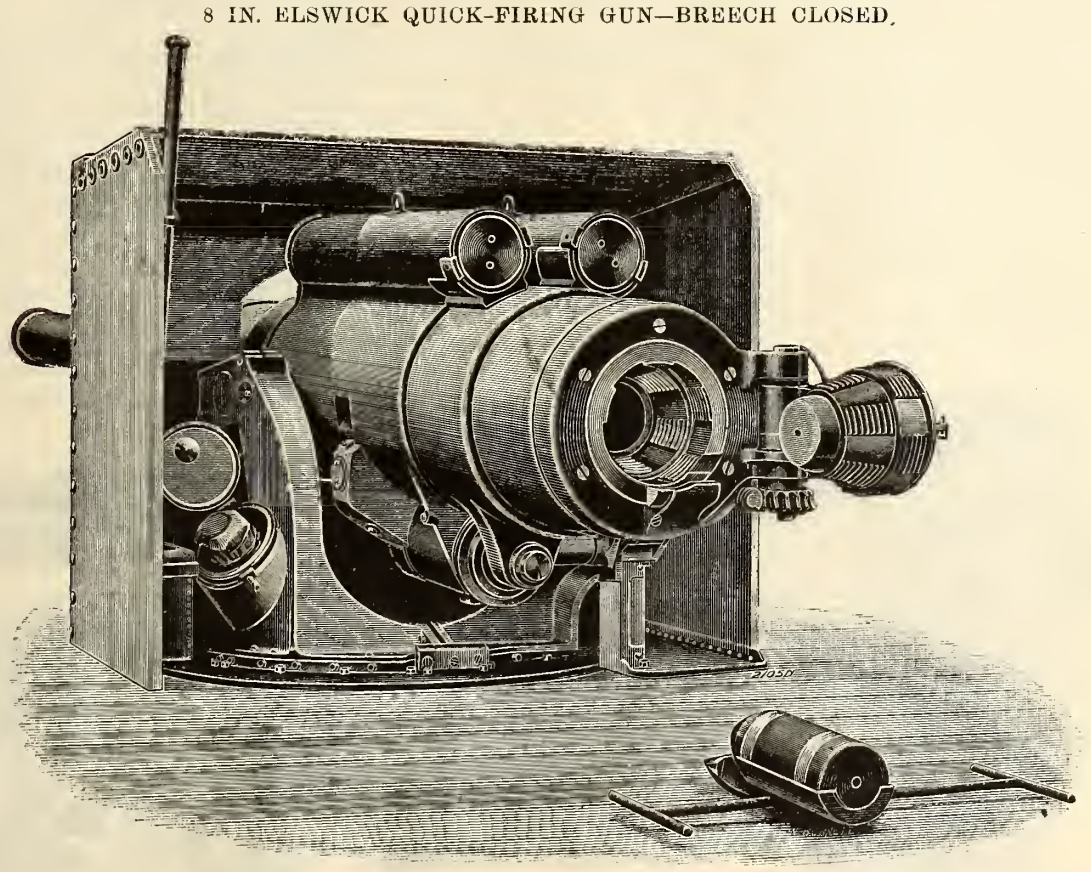
To operate the gear there is a hand lever on the lower side of the breech screw, which works always in a horizontal plane; it pivots on the carrier, and is attached to a sliding block by means of a connecting rod. A pin in the breech screw works in a vertical slot in the sliding block, so that a horizontal motion of the latter causes the breech screw to turn. The centers about which the gear works are on their dead points when the screw is closed, and it is therefore perfectly locked. The lever, if swung round, first unscrews and then brings away the breech screw. It will be seen that the coned screw is particularly well adapted to this system, for there are only two motions for it to pass through, and these are readily combined so as to give the operator but one. With the parallel screw matters are different, for, in addition to the two motions required with the cone screw, there is a long motion of withdrawal. Three motions can only be combined in a single one by a compound lever, which must also be moved through a large arc.

As regards strength, there is, of course, no doubt that a parallel screw would be stronger than a coned screw of equal length, and equal diameter at the small end; but there is no difficulty in adding to the length of the coned screw, so as to obtain the same strength as is given by a parallel screw of a given length. It might be argued in the same way that a full screw is more than double as strong as an interrupted screw of the same length and diameter, but the advantages to be obtained by the use of the interrupted screw are very great and it is adopted with the necessary and easy condition of proportionately increasing its strength.

But there is a considerable portion of the Elswick breech screw which is parallel, and the fact of coning the front portion causes the rear parallel portion to be of much larger diameter than if the screw were entirely parallel. Thus the section of each turn of thread is greater, so that the parallel portion of the Elswick screw gives a large total section of thread in a short length of axis. Taking this into consideration, the total length of the Elswick screw is about the same as the total length of a parallel screw of equal strength, and as the coned



8 IN. ELSWICK QUICK-FIRING GUN—BREECH CLOSED.



8 IN. ELSWICK QUICK-FIRING GUN—BREECH OPEN.

## THE ELSWICK 8 IN. QUICK-FIRING GUN.

screw can very readily be lightened by boring it out from the rear, the weights of the screws on the two systems are also about equal. Besides the great advantage of requiring only two motions for withdrawal or insertion possessed by the coned screw, there is a decided advantage gained by the distribution of the strain over a larger area of the breech hoop into which the screw gears. This was very clearly shown by experiment. Longitudinal sections of breech screws geared into tubes were constructed; the sections of the tubes having previously been marked with lines at right angles to their axes, heavy stresses were applied to pull the breech screws to the rear. Under the action of these stresses it was found that with the parallel screw the lines became distorted, showing that the interior layers of the tube had to bear the strain, the outer layers not being similarly strained. This distortion was not marked in the same way when the model of the coned screw was similarly experimented upon.

Another experiment to test the resistances of coned and parallel screws by the application of hydraulic pressure showed that the calculations were quite correct, and that the two screws yielded at the same point. This experiment was carried out by applying increasing pressures for certain periods. When these pressures became high, it was found that, although the coned screw was perfectly free to open each time the pressure was relieved, such was not the case with the parallel screw, which became very stiff as the final pressure was approached. It is very difficult to account for this result by theory, but practice showed that it exists beyond all doubt.

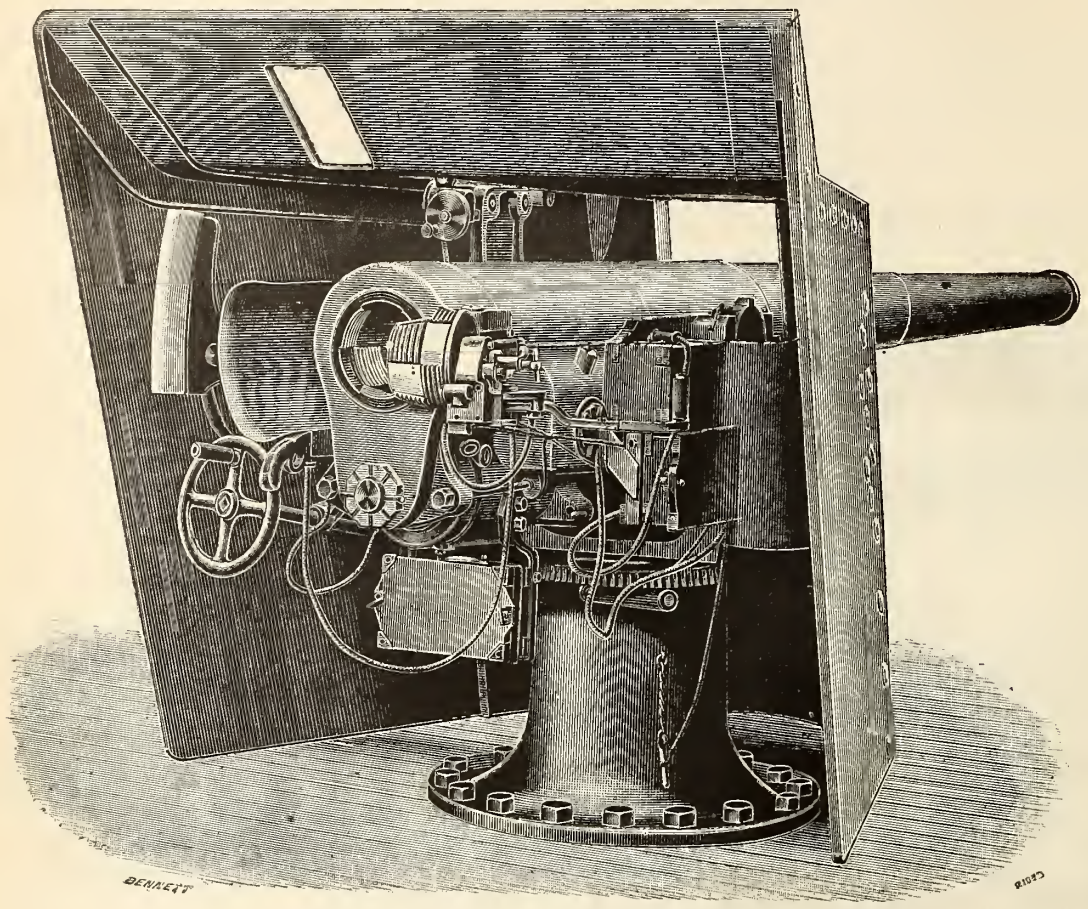
The Elswick coned screw embodies another feature of very great importance, which is, however, independent of the actual coning. We allude to the arrangement, due to Mr. Vavasseur, by which the interrupted sections on the coned portion correspond to the uninterrupted sections on the parallel portion. The stress is thus distributed throughout the whole circumference of the screw and of the breech hoop, a much more favorable condition than is obtained with the ordinary parallel screw.

These explanations ought to show that, if properly calculated, the coned screw has great advantages, and that the calculations are correct has been shown, not only by experiment, but also by the fact that more than a thousand guns have now been fitted with them, and no failure has as yet been recorded.

The extractor is an important item in the mechanism of guns using cartridge cases. It must be simple, strong and effective; but with large guns it must have a limited action in comparison with such guns as 3 and 6 pounders, for with the latter the extractor can advantageously be constructed to entirely eject the old cartridge case, and no harm will be done by its falling freely to the ground. With the larger guns, however, this cannot be allowed, both for the convenience of the gunners and for the sake of the cartridge cases themselves, as one of these heavy cases would certainly crush a man's toes if it fell upon them, and it would be badly distorted if it fell freely and struck hard ground or the deck.

For these reasons the extraction is arranged in the large quick-firing guns to take place in two motions. The cartridges are infallibly started by a very powerful extractor, which only has sufficient motion to insure their being free for the remainder of the extraction, the conical shape of the cartridge and chamber rendering a small motion sufficient for this purpose. The cartridges are then completely withdrawn and laid on the ground by means of a hand extractor, which readily fits over and firmly holds the primer.

The mechanical extractor is worked by the carrier in opening the breech screw. It consists of a rod passing through one side of the gun and fitting into the groove for the rim of the cartridge case, in such a manner that, when it is turned about its own axis, the fitted part acts as a lever and prises the cartridge to the rear. The extractor is brought back into its place, as the breech is closed, by means of a strong helical spring outside the gun; this spring also serves as a buffer to prevent the breech screw and carrier being swung too violently round. The extractor is fitted either on the right-hand side or the top of the chamber, so that it is out of the way of loading, or damage from the projectile, when the latter is being entered.



THE 4 IN. ELSWICK QUICK-FIRING GUN.

## ON A FLUID PRESSURE REVERSING GEAR.*

By Mr. DAVID JOY, Member.

WHEN I last had the honor of reading a paper on the simplification of valve gears before this institution, I concluded by saying, "and I am continuing my investigations in the same direction, with a very tangible hope that I shall be able very shortly to take a step further in the simplification of valve gears by about 30 per cent." That was in 1886, or eight years ago, and the paper which your council have done me the honor to accept for my reading to-night is the result of the eight years of work in that direction since that date, and I hope it will not be without interest to you.

When I made the statement quoted I had in my view the treatment of the valve gear of marine engines, which were then increasing in size and speeds of revolution with such rapid strides, on a plan on which I had long ago designed and constructed reciprocating steam and water power machinery with satisfactory success, by abandoning all direct mechanical connection between the piston and the valve, and actuating the valve directly by the motive fluid driving the engine, so arriving at about the ultimate limit of simplicity possible in this direction. Many steam hammers were made on this plan, and gave very satisfactory results, being extremely sensitive and perfectly controllable for the most delicate blows, even to picking a wafer off a watch glass without breaking the glass. Thousands of steam pumps have also been made on the same plan, the valve being driven either by steam or water with no mechanical connection.

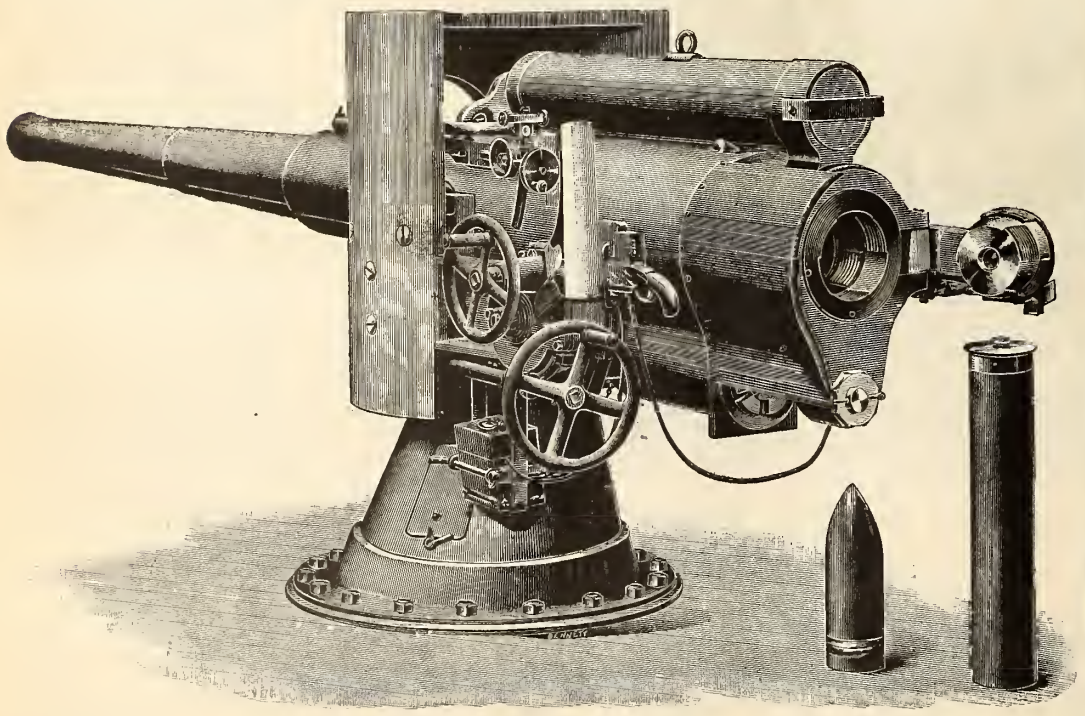
The great simplicity of the plan recommended it strongly for application to marine engines, and if successful promised a large field. But after some years' work in that direction I laid the plan aside, for the time only, I hope; not because of any mechanical difficulties in it that could not be overcome, but that the commercial element was not promising. It was, in fact, an advance, I think, too far in advance to find favor, a departure from ordinary practice too wide to be acceptable to either owner or builders. So, taking a medium course, instead of driving the valve itself by fluid pressure, where the fluid would always be in active motion, I proposed to myself to take only the half way step at once and to adjust and retain in position the machinery for moving the valve by the motive fluid, which would so mostly be in the condition of a static force only.

In carrying out this idea I returned, of course, to the absolute contact plan, driving the valve by a rod direct from the crank axle, but only one rod and one eccentric.

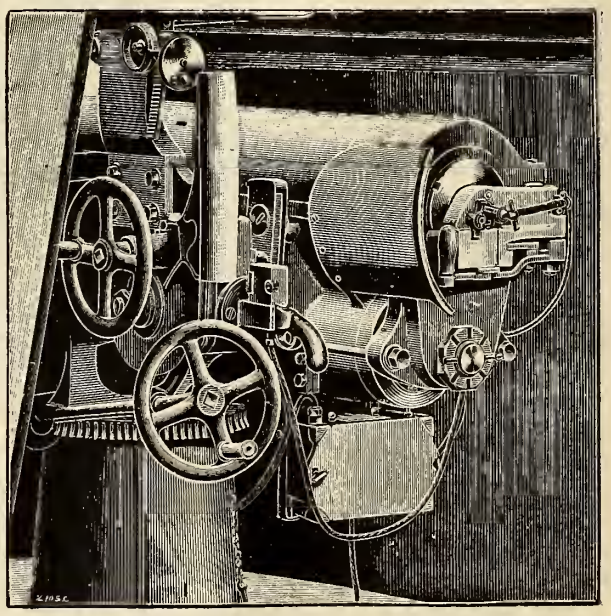
And now I shall not trouble you with the process by which I arrived at the result, but at once describe to you the machinery.

The principle of construction is simply that, in place of employing two eccentrics, set each at the proper positions, for giving forward and backward motion, and all intermediate points of "cut-off" necessitating the employment of the "motion link," and all the machinery required to move and hold it in position, I employ but one eccentric set upon the crank shaft and arranged to be slid across it between the two points, for forward or backward motion, and one rod direct up to the valve spindle. The method by which this sliding action is accomplished will be described immediately. By this arrangement all the requirements of

* Paper read before the Institution of Naval Architects, and given in *Engineering*.



THE 4·7 IN. ELSWICK QUICK-FIRING GUN.



ELSWICK 4 IN. QUICK-FIRING GUN, SHOWING BREECH CLOSED.

THE ELSWICK 4 IN. AND 4·7 IN. QUICK-FIRING GUNS.

the "link gear" are fulfilled, but with one-fifth of the number of parts, and giving a much more correct distribution of steam.

Referring now to the engravings (Fig. 4), A is a cast iron or steel square block, fitted on the shaft, S, in the position usually occupied by the two eccentrics in link gear. This block has cast with it, on opposite sides, two small rams, B $B^1$, the other two sides of the block being planed at the surfaces, *a a*, to receive the eccentric, E, which is bolted together centrally in the usual way, having the surfaces, *e e*, planed to slide on the surfaces, *a a*, of the square block, A. In the eccentric, and forming part of it, are cast two small cylinders, C $C^1$, into which the two rams, B $B^1$, fit.

We have now the eccentric mounted on a square on the shaft and free, while moving round with and driven by it, to be slid from side to side on that square; the direction of that sliding action being on the center line, arranged to be at right angles across the center line of the crank and connecting rods, when at extreme ends of the stroke and within the center line of the crankshaft, toward the crankpins, if inside steam lap is to be used, as is usual with piston valves, or outside that point if outside lap is required; the movement given to the valve being equally correct either way, and whether for forward or for backward going; each extreme position being for forward or backward going, the central position being mid gear; and any intermediate position giving any variety of cut-off. The movement of the eccentric in either direction and its control in any positon is effected by forcing in a non-elastic fluid at a pressure at either end of the crankshaft, which in this case, as for warships, is already hollow, as at $S^1$ (or in ordinary shafts it is drilled).

The fluid is put in motion in either direction by a steam cylinder, M (Fig. 1), operating on the piston of a cylinder, N, which serves as a reservoir for the fluid, transmitting the power through the pipes, P $P^1$, for forward going and on through the crankshaft, and so into the small cylinder in the nearest eccentric, suitable for carrying it over in the direction for forward gear, while the fluid in the opposite cylinder in that eccentric is passed on to the next following eccentric to move it over; and so on till the receding fluid finds its way by the pipes, P $P^1$, to the opposite end of the fluid cylinder, N; of course, the reverse action of the steam cylinder again returns the eccentrics to the original position.

Thus the positions of the eccentrics for forward or backward motion are secured without the intervention of any mechanical combination in the form of links, levers, screws, etc., liable to wear out or break down. And by the simple arrestation of the movement of the fluid, the eccentrics are maintained in any position, so giving any required point of "cut-off." The cylinder, N, is made of a sufficient capacity to contain a margin of about 25 per cent. more fluid than is required to fill all the eccentrics, pipes and other channels, etc., to be able to follow up the eccentries, if required.

From this description the general principles of the system will be easily understood; and to those familiar with the designing of fluid-pressure machinery it is well known how, working through the medium of a non-elastic fluid for the transmission of power, such machinery is peculiarly sensitive to exact and certain control.

Thus this gear lends itself specially to all the adjustments required in a triple-expansion engine at sea; and, though it would have made the paper far too long to go into any of the details for effecting these adjustments, it would not be complete without merely naming some of these. Thus, that while the engine is running, all the three cylinders may be "linked" up simultaneously, or each may be independently adjusted; and that, while so variously adjusted, all may at once be thrown over into full gear, either forward or backward, without any manipulation of screws, as in the reversing levers of link gear.

All these adjustments are effected by differentiating the amount of fluid between the two cylinders in any eccentric; and, as in the Maxim gun, the recoil of the shot is made available to discharge the exploded cartridge, supply a new one and fire it, so the tendency of each eccentric, when working expansively, to slip over into full gear is employed, by acting on a small valve in the eccentric by the motion of the engine, so allowing the fluid to change sides, under pressure of the tendency, to the amount for setting the point of "cut-off" required, when it may be locked in that position also by the fluid pressure.

There is also provision made in the arrangements of the valves and pumping gear of the fluid cylinder or reservoir for reversing by hand when the steam is not on, or for refilling any of the pipes, channels or eccentric cylinders; and, finally, this part of the gear may be linked up as a governor, employing the inertia of the fluid in motion and under pressure to move the valve of the steam reversing cylinder toward mid gear on the smallest increase of the speed of the engine, so linking up all three cylinders in that direction to the required amount to check the speed of the engine. The machinery for all these adjustments is of a small and very simple character and of a class in which I have had large experience; and for all details there are ample precedents.

The advantages of the gear are—first, its simplicity of construction and fewness of parts, all such parts also being of ordinary form commonly in use, with the further advantage that, as only one eccentric is required for each valve, that may be made of double strength and surface, if desired.

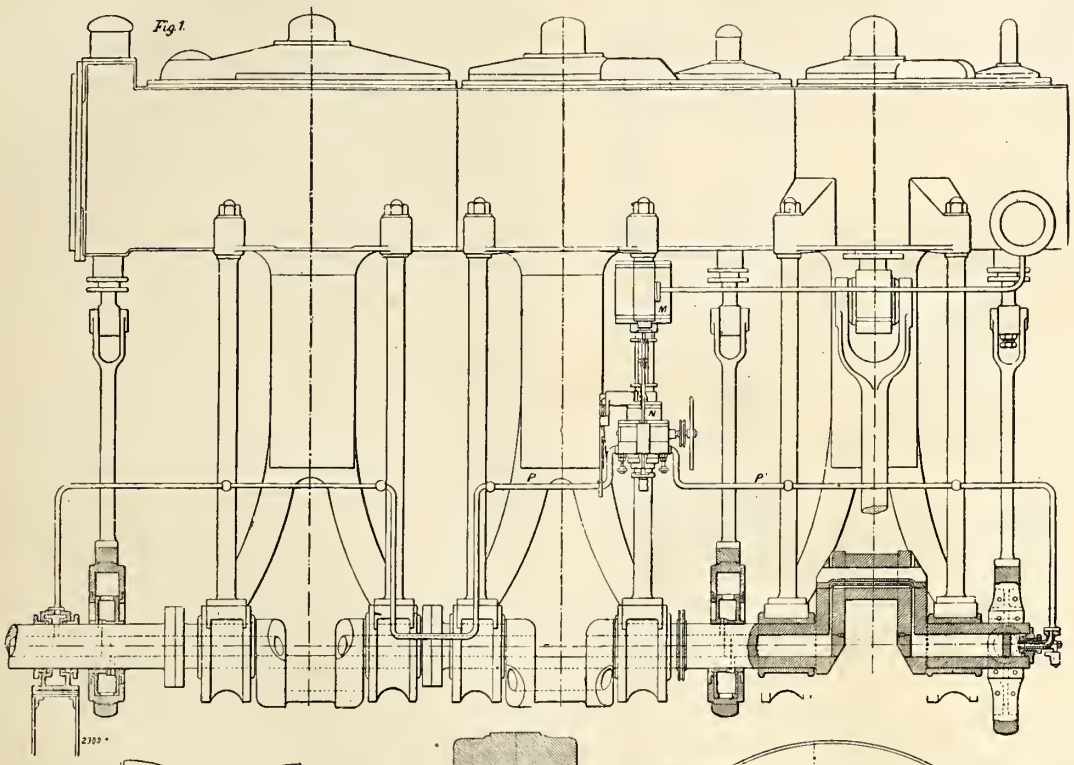
Resulting from the above, the gear is very much less costly than link or any other gear, fully by half, as not only are there fewer parts, but none of these are complicated and costly forgings, as motive links, requiring difficult and expensive tooling; almost all the work consisting of simple castings in steel or iron and requiring chiefly boring and turning, the easiest and least costly operations in the tool shop. Then, having far fewer parts, it is less liable to break down; less attention and lubrication are required. Indeed, if wished, the whole of the lubrication on the crankshaft may be performed by the motive fluid itself (using oil), which may be recuperated automatically by the engine itself while in motion.

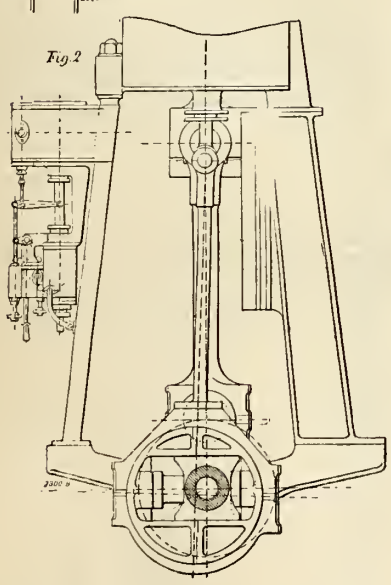
Again, it fits into the position of the link gear exactly, requiring no alteration whatever in the ordinary type of engine. Further, the newly designed part connected with the fluid pressure machinery may entirely break down without destroying the efficiency of the engine, which will still continue her voyage in full forward gear; for, if the engine is working expansively, the only result of the entire failure of the fluid gear is to allow the engine to slip into full forward gear, while, if working in full gear, there is no strain at all upon that part of the machinery.

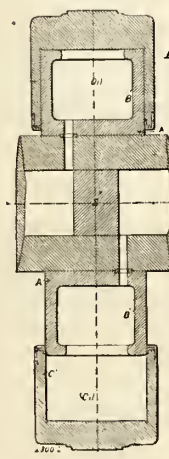
And now, though this gear was originally and specially designed for marine engines, it is really a valve gear of general application for any class of steam engines and suitable to be employed wherever link gear may be used. Therefore, in selecting an engine on which to test its efficiency, I chose a locomotive, as offering opportunities for the most crucial tests to be carried out in the shortest time, as also other important advantages; as the greater ease with which experiments can be conducted and recorded on land than at sea, the freer access to the machinery by numbers, whether of workmen or of those wishing to inspect, as compared with a crowded engine room at sea. Alterations, repairs or additions may be readily made, variations in loads or in speeds may be effected, continuous working may be maintained, independent of weather or tide; but, most of all, a much more crucial and varied series of tests may be crowded into a very much shorter time than with engines at sea. Thus the engine fitted with this gear has been at work about a year, and during that time has had the reversing gear as frequently manipulated, shifted from forward to backward going, and changed about to all degrees of expansion as could have occurred in a channel steamer in six or seven years, or as in an ocean-going steamer in quite an unknown time.

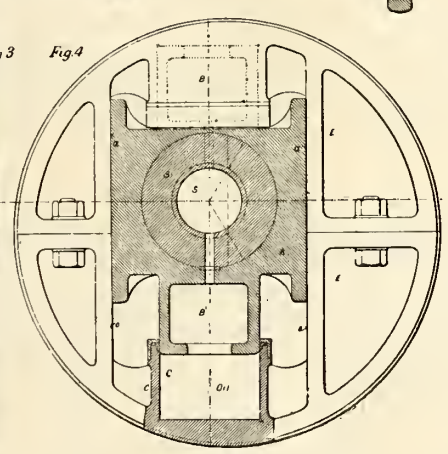
With regard to the newly required constructive details, several points of interest arose and had to be dealt with. One or two only I will name. Thus it was objected that, at the point where the stationary fluid in the pipes at either end of the crankshaft met that which was revolving rapidly in the shaft, heat would probably be generated. This never occurred, but its possibility was met by enlarging the spaces or channels at that point, so allowing room for the stationary particles to interchange gradually among those rotating rapidly.

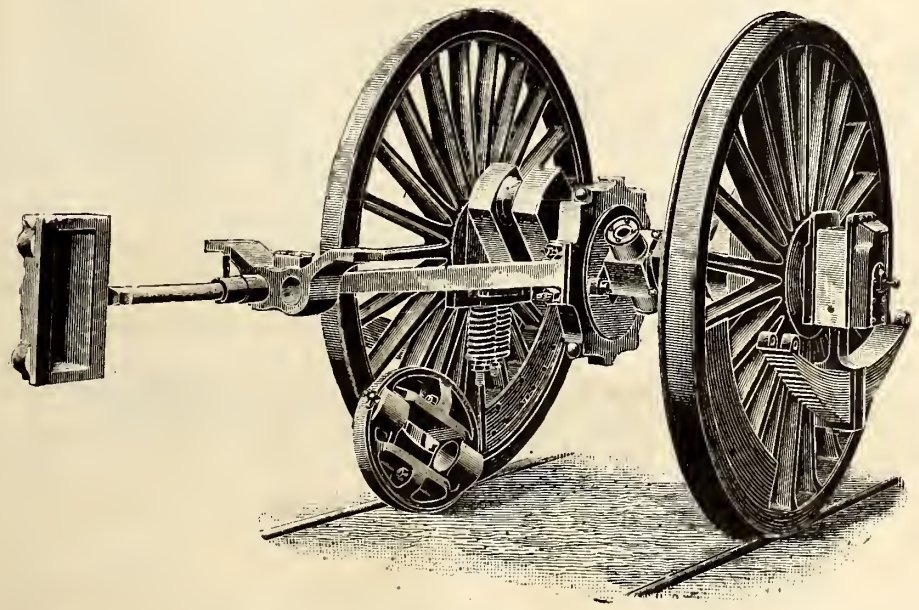
Again it was urged that, as the fluid had to sustain the reciprocating effort of pulling and pushing the valve, a throbbing or pulsating action would be generated. This never has existed, for, whether running slowly or very fast, and even with a considerable amount of air in the pipes, the whole gear runs with the solidity of a gear of steel with no intervening fluid. The most suitable fluid to be employed has also been



JOY'S FLUID PRESSURE REVERSING GEAR.

subjected to investigation, and if frost is not feared and lubrication is not contemplated, then any non-elastic fluid will do; but probably one of oil and nine of water will be found most convenient and cheap.

For packings I, of course, used the ordinary leather cap packings, of which I have had very satisfactory experience under pressures up to 5,000 lb. per square inch. The practice in the case of the Westinghouse brake pointed in the same direction; but, thinking it well to be independent of organic material, I have been trying to get at a figure in which to employ metal, and some of the results are on the table.

Now it only remains for me to refer you to models, drawings and photographs on the walls and on the table—among these, to the original machine on which I satisfied myself that the broad principle upon which I proposed to work was practicable, and cards of diagrams taken from it giving the valve stroke—and also to inform you that the locomotive on which this gear has been tested will be at the Victoria Station of the London, Brighton and South Coast Railway.

## THE LUHRIG GAS MOTOR CAR.

ALL gas manufacturers have the greatest interest in attentively watching the tentatives made to apply gas motors to tram cars, not only because it is a question of the prospect of an increase in the consumption of gas, but especially because such application would have the effect of greatly increasing a day consumption that would be assured for the whole course of the year, and would more completely and more regularly utilize the *materiel* of our gas works.

Mr. Kemper, in a communication made to the congress of Dresden, naturally begins by analyzing the different systems now in use:

Traction by horses renders our streets unhealthful, and, besides, the general expenses of maintenance and interest on the investment are very heavy. Steam tram cars are scarcely practical in the interior of cities; the exploitation of compressed air tram cars is very costly, even where natural forces are at one's disposal; and among the electric tramways, those operated by the trolley system offer decided advantages from a practical and economic point of view, but, as an offset, they present serious inconveniences, from an æsthetical standpoint, with their cumbersome and unsightly poles along the sidewalks.

These points stated, Mr. Kemper passes to gas motor tram cars. These cars carry their supply of compressed coal gas stored in cylindrical receivers about 11 in. in diameter and of a capacity of from 55 to 90 cubic ft. The same regulators employed by railways for lighting by the Pintsch system are used for the discharge in gas motor tram cars.

The gas can be taken from any point of the pipe line, provided that the section of the conduit is large enough. It is necessary to establish there only a small station in which the compression of the gas and the filling of the receivers can be effected. According to the length of the road and the number of cars running upon it, there should be established one or more of

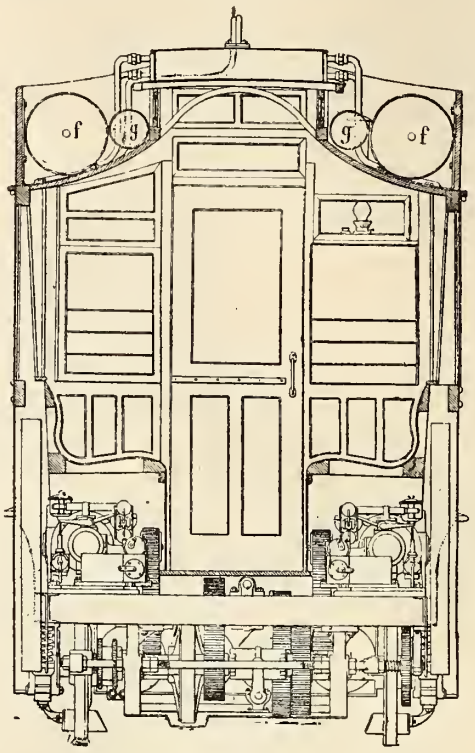



FIG. 3.—TRANSVERSE SECTION THROUGH THE AXIS OF THE DRIVING SHAFT.

such stations, each costing, everything included, from $2,000 to $3,000.

In these stations there is a stationary gas motor which, through a belt, actuates a compressor that is capable of compressing to 8 atmospheres 210 cubic ft. of illuminating gas per hour. The section of the suction pipe is 4 in. The gas passes through a 500 burner meter, above which are fixed two Scrabetz apparatus for preventing the fluctuation of the gas. The apparatus very advantageously replace the rubber pockets employed in gas motors. From the compressor the gas flows to the reservoirs, which have a capacity sufficient to furnish two cars with gas at six atmospheres.

The gas motor of the compressing station consumes about 8 per cent. of the gas to be compressed. It is possible to compress 350 cubic ft. of gas per horse hour.

There are at present two systems of gas motor tram cars in operation, the Guillieron & Amrein system and the Luhrig system. It is the latter that forms the principal object of Mr. Kemper's communication.

The Luhrig establishment is constructing two types of gas motor tram cars. We represent herewith the large model, which is capable of accommodating 16 persons in the interior and 11 upon the two platforms, which makes 29 with the engineer and conductor, that is to say, more than an ordinary one horse tram car is capable of containing.

The motion is given by two twin 7 h. p. engines placed lengthwise under the seats, in such a way that the flywheels are placed at the exterior and behind the backs of the seats. The motors are constructed especially for this object by the Dentz works, and, in order to gain space widthwise, the cylinders of the motors are placed opposite each other.

The two motors are capable of acting upon the driving shaft either together or separately. It is possible to give the motors three velocities by means of levers maneuvered by pedals—a velocity of 100 revolutions per minute for working to no effect during stoppages, and one of 200 revolutions and one of 240.

The cold water reservoirs are placed upon the roof. The gas reservoirs are five in number—four under the floor and one upon the roof. The pressure of the gas is reduced to from 1 to 1½ inches by a Pintsch dry regulator.

The products of combustion pass directly into a receptacle in which the noise of the exhaust is smothered, and thence to a condensing apparatus upon the roof, whence they make their exit into the open air without noise and nearly without odor.

On each side of the car there is a door with two leaves, and two small doors that prevent any detail of the machinery from being seen. When these doors are open, all parts of the motor and of the transmission are easily accessible. The specification of the Luhrig patent dwells especially upon this arrangement.

The change of speed is effected by pressing a pedal which acts upon a lever. The latter in turn acts upon the governor of the motor. The starting and stopping are effected by means of two hand levers that engage or disengage the toothed wheels that transmit the motion. A sudden stoppage is produced

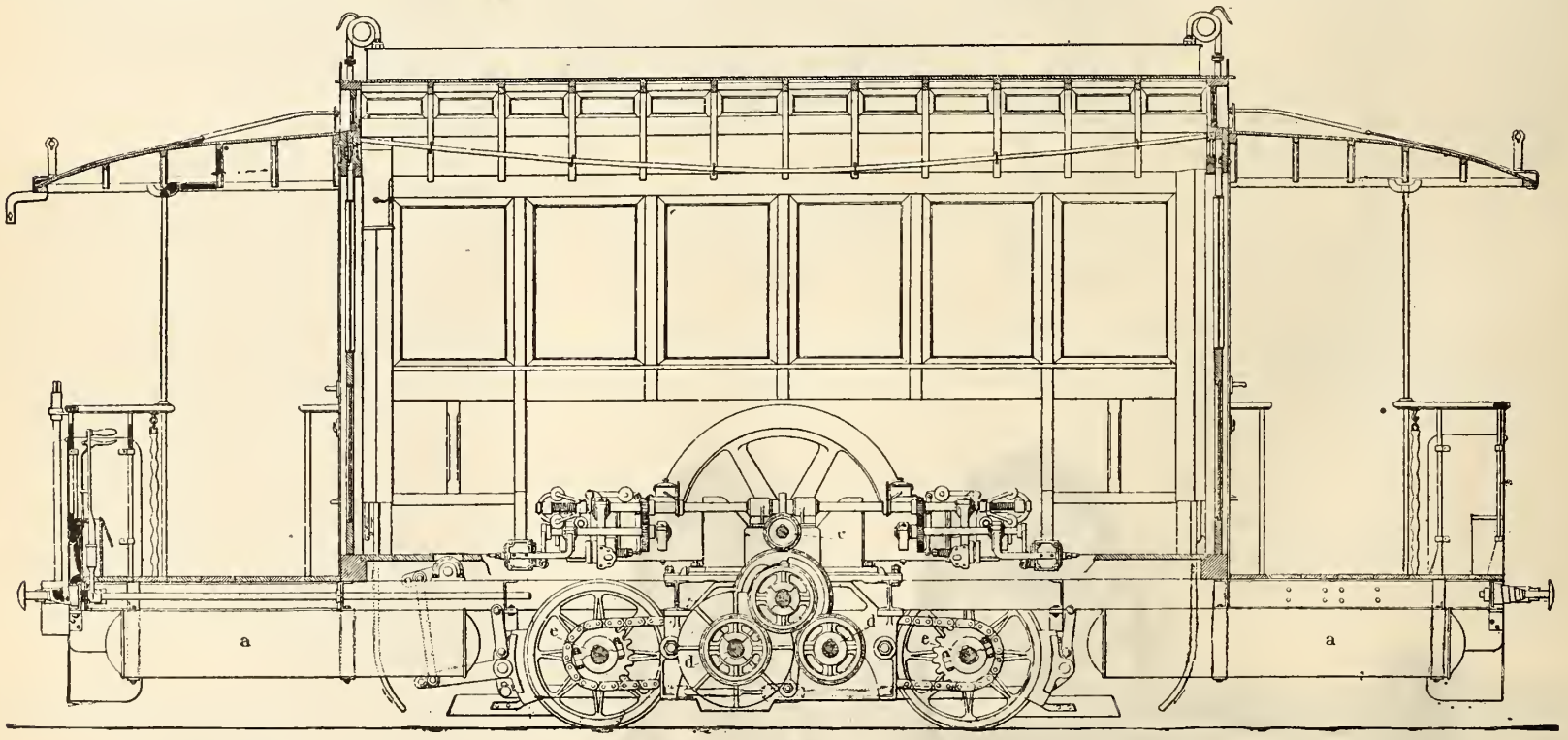



FIG. 1.—LATERAL ELEVATION—ARRANGEMENT OF THE MOTOR AND THE DRIVING GEAR OF THE WHEELS.

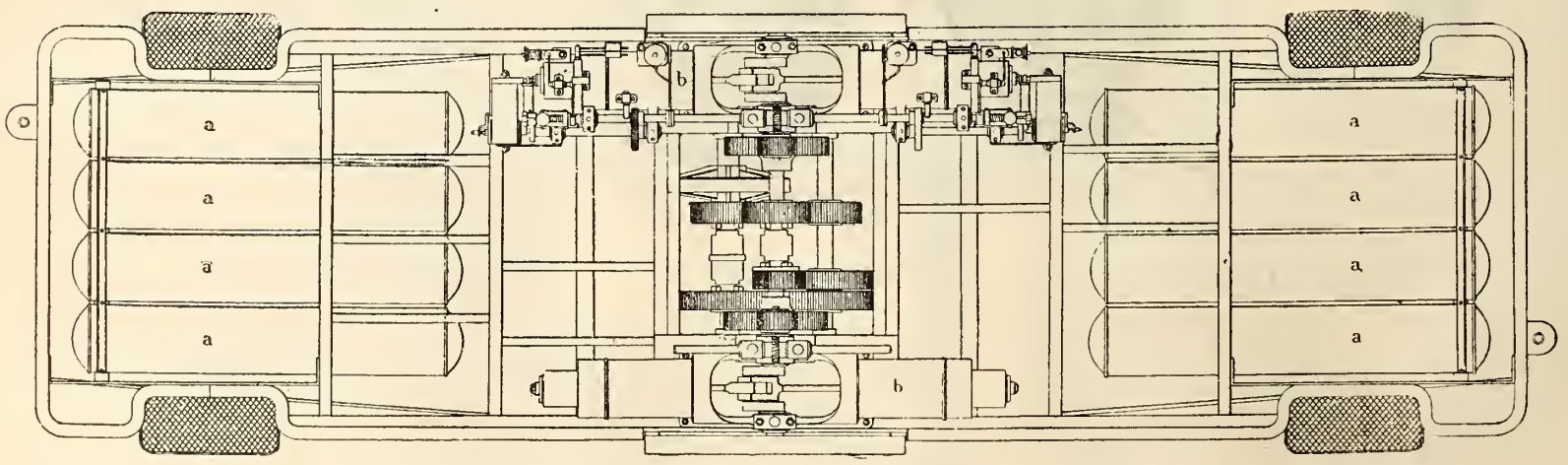



FIG. 2. PLAN.

*a a*, reser oirs of compressed gas; *b b*, two-cylinder gas motors; *c*, driving shaft; *d*, transmissions between the driving shafts and the wheels of the car; *e*, driving axles; *f*, cold water reservoirs; *g*, exhaust condenser.

## LUHRIG'S GAS MOTOR TRAM CAR.

by means of a hand wheel that acts upon the brakes. These maneuvers are much simpler than they seem to be at first sight, and any new hand can learn them very quickly.

Externally, the car is scarcely distinguishable from an ordinary horse car. It has at the most a somewhat heavy appearance on account of the large door with two leaves that is placed on each side, and of the wide escutcheons that conceal the reservoirs on the roof.

This large sized car weighs, when empty, about 7½ tons, which would indicate for a complete load of 29 persons, of 150 pounds each, a weight of 9½ tons. In some experiments, the car, with a complete load and at a medium speed, easily ascended a gradient of half an inch to the foot.

Along a gradient of two inches to the foot, which is a very heavy one, and one rarely met with in cities, the speed of a car with a 14-horse motive power and a load of 9½ tons is 4·4 feet per second. The power absorbed by the transmissions is negligible, because the Dentz motors are capable, as a general rule, of developing 10 per cent. more than their normal power. This speed of 4·4 feet is that of a pedestrian. Such gradients present themselves only on short lines, and so reduced a speed has no serious inconvenience. It would be important, however, if the line were lengthy, and it would then be necessary to employ the car that we have just described only in cities where the gradients are moderate.

For the exploitation of roads with heavy gradients, the Luhrig establishment has constructed a smaller car with a single 10 horse power motor, and in which the two-cylinder engine is placed under one of the seats, while the cold water reservoir, the receptacle for expelled gases, etc., are placed under the other seat. According to Mr. Luhrig, this car weighs, empty, about 4½ tons, and is consequently no heavier than one run by an electric motor. It is capable of accommodating 22 persons, and with a complete load the total weight would therefore be about 6 tons. According to calculation, it would be able to ascend a gradient of 2 inches with a speed of 5 feet per second—that is to say, with half of its normal speed. This is already a great progress, but it is still far from what may be attained with electric tram cars. However, the studies that are being pursued will permit of sensibly diminishing the weight so as to make it possible to attain the normal speed under all circumstances. The cost of these cars is not well determined, and will not be until the orders received shall permit of a regular manufacture. The builders believe that it will be possible to sell the large model at $4,450 and the small one at $3,500.

The consumption of the gas may be ascertained at any moment from a manometer placed in the interior of the car. The large car has receivers of a total capacity of 65 cubic feet. If the manometer indicates that the pressure of the gas has lowered by two atmospheres, for example, during the trip, it will at once be seen that the consumption of gas during the trip has been sensibly $2 \times 65 = 130$ cubic feet. Mr. Kemper in this manner found that the large car, with a mean load of from 10 to 12 passengers, consumed, per car and per mile, 43 cubic feet of gas on one occasion and 45 on another. As these observations were made while the car was new and the transmissions consequently still gave too much friction, it must be admitted that in a regular exploitation the consumption should fall below 40 cubic feet. The small, single motor car consumes less than 35 cubic feet, according to the engineers of the Luhrig establishment. It may, therefore, be said that, in admitting into the calculations of the expenses of exploitation a mean consumption of 40 cubic feet per car and per mile, we have not taken too low a figure.—*Annales Industrielles.*

## TRANSMISSION OF POWER BY FRICTION PULLEYS.

By G. D. HISCOX, M.E.

MUCH apprehension exists among our practical mechanics and inventors as to the applicability and efficiency of this little understood method of transmission and direction of power in the great variety of machinery to which it is applicable. We are often asked what the efficiency of this method is in comparison with belts and gearing, as well also of the various materials that can be run in contact for this purpose. There seems to be a largely increasing desire to bring the running parts of machinery into a more compact form and less noisy than the geared system allows.

For this purpose we illustrate some of the many forms and combinations of power and speed possible in this line, together with the efficiencies that may be expected from the various materials used as friction surfaces.

The value of friction with contact pulleys is fully equal to leather and rubber belting of 180 degrees lap, when the same material is in contact in both cases; the difference being the loss from unsymmetrical cones and curved surfaces, which produce a constant angular slip. In these forms there are mitigating circumstances which make their use necessary in order to accomplish specific results, and in which the speed relation of the two pulleys should be increased to compensate for the slip.

Fig. 1 is a type of the cylindrical-faced pulley system now largely used on quarry and other hoisting engines, where intermittent work is required, by which clutches and clutch friction pulleys are avoided. For high speeds, as for spindles, circular saws and dynamos, its compact and efficient transmission is bringing this system into high repute.

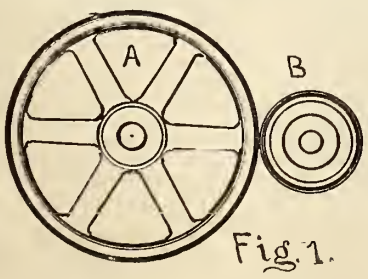


Fig. 1.

For any speed a leather-faced driver, A, with cast iron driven pulley or pinion, B, gives an efficiency of from 32 to 34 per cent. of the pressure on the faces in contact in stress of power.

Thus a pair of friction pulleys running with a speed of 1,000 feet per minute at a maximum pressure of 100 pounds per inch in width of face contact will have a working stress of 34 pounds per inch, or 34,000 foot pounds, or say one horse power per inch of face.

The friction of a wood pulley driver on a cast iron driven pulley is claimed to be as high as 50 per cent. power strain in units of the compression, and as wooden pulleys are now largely represented in the mill trade, this material is a most convenient application, affording the highest efficiency.

The propriety of using the wooden or leather faced wheel as the driver is apparent, especially with high speeds, as in starting, the iron pulley, if a driver, is liable to cut grooves across the soft wooden or leather faces.

The bevel and miter form of friction gearing, Fig. 2,

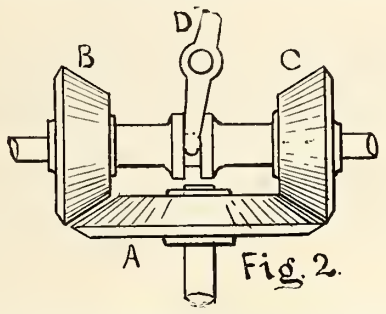


Fig. 2.

is largely in use for driving centrifugal driers and extractors, reversing speeds for wood moulding machines, for which purpose this form of power has been adopted by our most reputable woodworking machinists. Its frictional coefficient, on account of imperfect contact, is not quite as great as with cylindrical-faced pulleys, but may be safely estimated at 30 per cent. of the compression; the power transmitted otherwise at the same ratio of face contact as with cylindrical pulleys.

The old style V gear, Fig. 3, is still in use for heavy

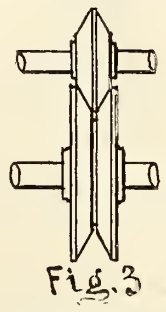


Fig. 3.

and rough work in quarry and mill hoists and occasionally in machine shop practice. It is a power consumer. The angular form of the friction surfaces, 50 to 60 degrees, tends to increase its power stress in percentage of its compression. The loss by angular face friction more than compensates for its grooved form of contact.

The contact velocity in computing for power should be taken at the smallest contact diameter of the driving pulley; the circumferential difference between the inner and outer contact being lost velocity.

The multiple groove friction gear, Fig. 4, was a great

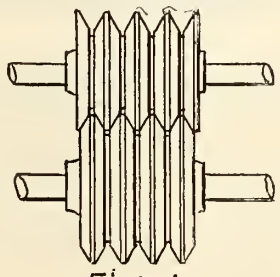


Fig. 4.

improvement over the single large groove, by the amount of its extension contact. This form being almost wholly confined to metallic contact, its coefficiency cannot be relied upon for more than 30 per cent. of the contact compression.

The grooved form of friction gear of any angle and number of grooves is subject to severe wear by the angular rubbing surface causing the outer portion of the driving pulley and the inner portion of the driven

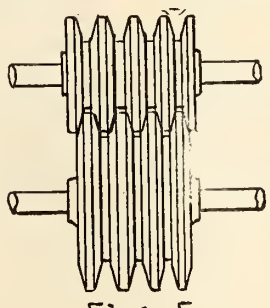


Fig. 5.

pulley to wear faster than the opposite portions of the friction surface, and lessening the area of contact; thus showing the increased value of small grooves for efficiency in wear, and better, finally, by eliminating the grooves in favor of a plain surface.

The Van Haagen type of grooved gear was introduced for its holding efficiency in percentage of the contact pressure.

Its angle of contact, about 15° with the plane of revolution, giving a firmer grip, with an efficiency of about 60 per cent. of the contact compression, shows excellent results for some purposes; but its angular contact friction and surface wear is largely increased over the shallow groove system.

This system for angular feed motion has been in use by some of our leading machine builders as illustrated in Fig. 6. It is not an easy gear to make,

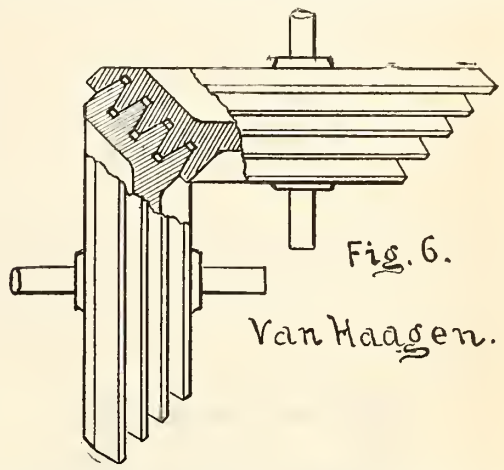


Fig. 6.
Van Haagen.

but for angular transmission seems to be very efficient in the uses to which it has been adapted, having by its miter grooving an enlarged contact and increased friction from its small angle, requiring but small compressive force for its assigned work. Its efficiency is greater than with the conditions in Fig. 5, having a possibility of 80 per cent.

The form of transmission of power in cross line shafting of small angle, Fig. 7, has a small traverse creepage

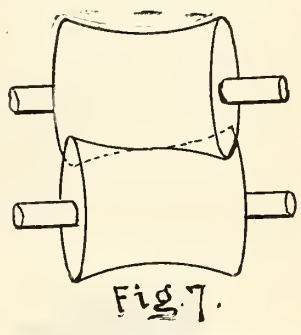


Fig. 7.

due to the angular contact of the concave faces of the pulleys. It may be used in place of skew gearing for light work. It is easily made of wood or leather disks for very small pulleys, or for larger ones the wooden pulleys found in trade may be concaved on their face to fit the position. Its efficiency for small angles is nearly equal to the cone pulleys, Fig. 2, or about 28 per cent. Fig. 8 represents one of the least objectionable

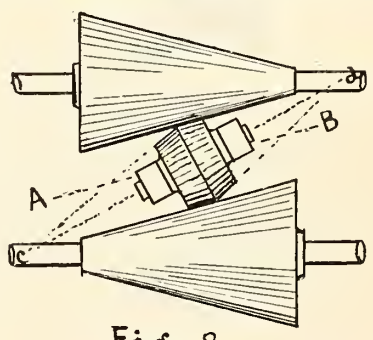


Fig. 8.

of the cone speed trains, the conveyor pulley being a double cone, with their conical apices exactly meeting the apices of the driving and driven cones, *c*, *d*, in the cut, and their line of movement for variable speeds parallel with the face of the driving and driven cones as shown by the dotted line, A, B, Fig. 8. This form of speed cone will transmit the same amount of power as a belt of the same width of contact surface and the same speed.

Fig. 9 illustrates two methods for variable speed from

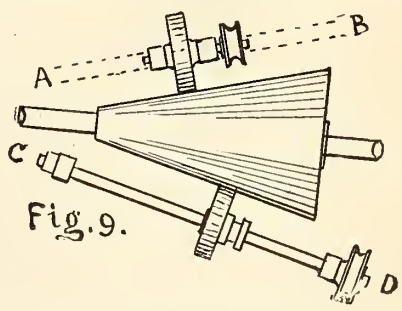


Fig. 9.

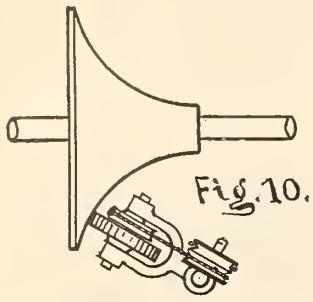
a cone driver. A traversing pulley and band wheel on a short shaft in a frame, traversing a bar, A, B, which may be made to rock by a lever to throw the driven pulley on or off the cone driver.

A convenient and simple device for running a sewing machine. This requires a lateral movement of the band which does not interfere with the proper running of the machine, when there is 2 or 3 ft. distance between centers.

On the opposite side of the last figure is represented the driven pulley, on a feathered shaft, *c*, *d*, moved by a sliding yoke with a fork on the hub, which

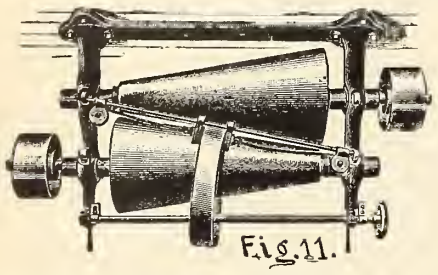
allows of a stationary point for the machine pulley. This should also have a rocking motion on a bar for starting and stopping.

A variable speed from a short concave driving cone, Fig. 10, in which the driven pulley moves along the




concave surface of the cone in a yoke turning on a movable center for producing friction pressure and starting and stopping. With this device the band may be direct to the machine, but in which the driving end will have a swinging motion as the speed changes, or may be arranged with two bands and a double groove wheel at the pivot end of the arm.

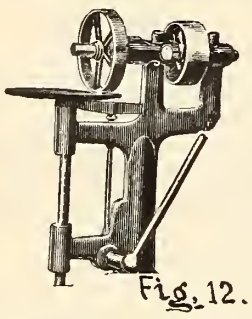
In Fig. 11 we have one of the latest devices for




variable motion, and also for a steady speed from a variable speed power.

It consists of a pair of cones pressed closely together with a short belt running loosely between, guided by a shipper and lanyards for operating change of speed by hand, or attached to a governor for automatically controlling a uniform speed from an unsteady power. The speed variations are thus made easier than with the ordinary belt shipper. A complete device which can be placed as readily as a common hanger. It is manufactured by the Evans Friction Cone Co., Boston, Mass.

The friction disk, Fig. 12, is one of several simi-

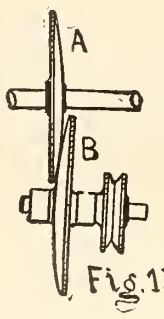



lar devices for variable speed and variable power in their inverse ratio.

It has been adopted by a leading manufacturer for light drill presses, and is a most sensitive application for the needs of small drills, by starting the drill spindle with the pressure on the drill and varying the speed to the exact requirement of the work.

The coefficient of driving power is estimated at 30 per cent. of the pressure, falling slightly below the value of a belt of the same width.

The Wright friction disks, largely in use for driving sewing machines by power, in which A is the

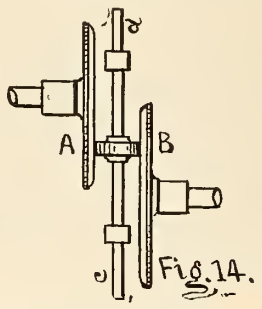



power shaft, carrying a spherical-faced disk, and B a similar disk mounted on a small countershaft with a band pulley and band running vertically to the sewing machine.

The countershaft is mounted in a frame pivoted beneath at the half distance of the contact surfaces, and with the two motions necessary for operating speed and pressure, controlled by a single treadle that produces contact for slow motion and by further pressure swings the curved friction surfaces for a higher speed.

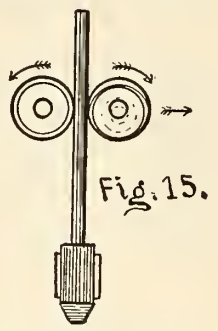
Variable motion in parallel lines, of which Fig. 14 is a type, where A and B are friction disks on parallel shafts of small central distance, and *c*, *d* a traverse shaft carrying a narrow pulley. In this system the disks may have a fixed compression and the transmission pulley run on and off from one of the disks for starting and stopping.

A modification of this system is in use for driving centrifugal driers by making both disks the drivers on two central lined shafts, and the vertical spindle, *c*, *d*, the driven shaft of the centrifugal machine. By concaving the driving disks at their centers and with the small pulley traversing on the feathered shaft, *c*, *d*, the speed of the centrifugal may be controlled, checked and stopped by the movement of the spindle pulley to the center of the driving disks, where the concavity in the disks releases it from friction.




The destructive vibration which the cone-driven centrifugals are subject to may be avoided by this system of transmitting the power to opposite sides of the driven pulley. By this method the coefficient of friction power is doubled by virtue of the double contact.

The drop press now stands at the head of all the devices used in forging metals. The accuracy of its work in the art of moulding articles of iron and steel, by a single blow, is a marked advance on the processes of but a very few years past. Fig. 15 represents the

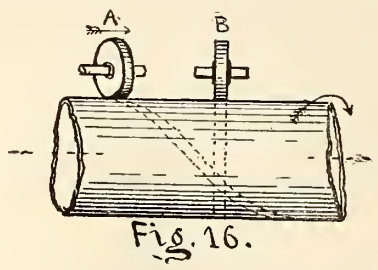



modern method of handling the drop hammer, which is attached to an oak board between two revolving rollers or pulleys, one of which has a release grip by the movement of an eccentric shaft actuated by a lever and lanyard or rod.

So well adjusted are the moving parts that any desired blow may be given. Its simplicity makes its duplication available to any extent in manufacturing the thousand varieties of articles of hardware and the parts of delicate machinery.

The contact force being double, its efficiency for lifting is about 60 per cent. of its contact pressure.

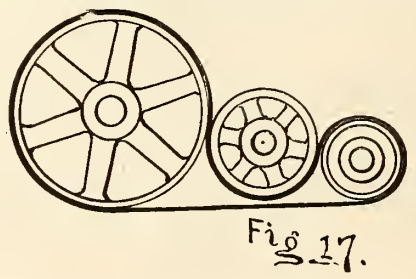
Frictional rectilinear motion from the angular position of a sheave or pulley rolling on a revolving barrel or long cylinder, Fig. 16, is a type of the Judson sys-




tem of railway propulsion, the frictional efficiency of which was increased by the use of small trucks carrying several pulleys with pressure from the weight of the car.

The speed of the car being controlled by swiveling the truck through about 45°, as in the positions at A and B, in the cut.

The combination of a compression pulley, for increasing the traction of a short belt, is shown in Fig. 17. It gives a large coefficient of power in proportion




to the tension on the journal bearings, and which may be almost entirely relieved of undue strain by a judicious proportion of the friction pulley to the driving and driven pulleys, and thus obtain from a single thin belt more than double the duty of the belt alone. For dynamos and other high speed machines, the heating of journals may be nearly eliminated by the proper adjustment of this method of speed transmission.

## GOLDSMITHS' WORK: PAST AND PRESENT.*

By MRS. PHILIP NEWMAN.

THE subject on which I have been honored by being asked to speak to-night is a very large one, and one very near to my heart. It embraces so many points, its history and theory have been written about, spoken about, divided and subdivided under so many heads, that historically and theoretically there is little that is new to say; but, curiously enough, since the monk Theophilus wrote his famous treatise in the eleventh century, little has been written on the practical side of the question; and, as it is before the applied art section of this great institution I have the pleasure to appear, I shall venture to let my paper take a more technical form than would be desirable for a general audience.

Alloying, melting, working, coloring and polishing gold have been my chief studies and occupation for over 25 years; for long years before that I modeled, designed and drew for goldsmiths' work; and though I should easily be beaten in the use of a blowpipe, and find it a little difficult to arrange very fine grains with a pallion of solder, yet I think there is no calculation for alloy or mixing of the precious metals, no pot for melting skittle, plumbago, or other kind, no tool for working, no direction of heat, whether a sharp point of flame, a blunt one, or an all-over blast, with which I have not a perfect acquaintance. The different metals necessary to mix with the gold to obtain the softest and richest effects for enameling, or the different qualities of solder best to use for various kinds of work, wet or dry color, are all familiar to me; and this everyday experience of mine leads me to hope that I may be able to interest you in the working of the gold and show how it was done in former times and how it is done now.

There seems to be a consensus of opinion that gold was the first metal discovered. It is beautiful in color, was found in rivers, in sand and on the surface, while other metals had to be dug from the bowels of the earth. It is so attractive in appearance, the most untutored savage would observe its beauty; and it was universally known.

Goldsmiths, that is, men who work in gold, are supposed to have been the first workers in metal, and to have been the pioneers in all the manual arts.

There is a popular idea that gold can only be fashioned by the aid of heat, but, as I had occasion to point out in a lecture I gave last March before the Society for the Encouragement of the Fine Arts, much of the ancient work was made without the application of heat at all.

In every small treatise, in whatever language it may be written, on our subject, one quotation from an old author is always given, and as there is no better way of expressing the qualities of gold, I will repeat it: "Gold is very ductile, a spreading and oily metal;" and to use an old workshop term, "it is very kind." It can be hammered, drawn as wire and fashioned without heat; and it is almost the only metal which is ductile enough for this without the aid of steam power.

If we examine many of the oldest specimens, we shall find that they have been worked cold, beaten and twisted into shape by sheer force, which is, literally, an application of heat, but it is not so technically.

There is a tradition that Tubal Cain was the first to make gold leaf. Anyhow, the art of beating gold is so old that, like the early history of most things, "its origin is lost in obscurity." But, as every handbook will tell you, Homer and Pliny both refer to it. Homer also mentions and describes a blast furnace with 20 crucibles, and melting pots have been found in many places in Egypt.

It is quite possible to have hammered together the little particles of gold found on the surface of the earth and elsewhere, and made them into rough utensils or ornaments without melting the gold at all; but probably as soon as furnaces and melting pots were known, the gold was melted and run into a rude skillet before the hammering process began.

It would take up too much time to mention the various places where gold was found in bygone times, or to enumerate the usual sources from whence gold is obtained now. Suffice it, for our purpose, to admit that the very first thing a goldsmith needs is pure gold; not that pure gold can be worked, for it cannot. No really chemically pure gold was ever worked, or ever could be. Many ornaments of refined gold are mentioned by old writers, but in no instance have I found any record of any antique made of pure gold. Purity in this metal is represented by the number 24; standard gold has 22 parts pure to 2 parts of alloy; 18 carat gold has 18 parts pure to 6 parts of alloy. French gold, called 18 carats fine, is not so pure as the 18 carat gold used here; it only assays to 17 3¾, or a quarter of a grain worse than would pass Goldsmiths' Hall as 18 carat. The French gold is alloyed with copper, which gives it the reddish tinge. We alloy with both silver and copper, and no point has been more discussed and quarreled over than the exact amount of silver and copper necessary to make the best alloy. It is only 6 parts in 24—not much to wrangle about, you will say.

I will not attempt to give you all the formulæ, or to decide which is best, only, like everybody else, in one particular proportion of silver and gold I believe, and in no other; even when 22 carat gold is to be prepared, the 2 parts of alloy are matters for much comment and dispute. I know two really estimable men who quarreled bitterly on this question, the one said that of the two parts one should be silver and the other copper, while the other stoutly maintained that the proper proportion was one and a half copper and half silver.

Well, the gold being alloyed to 22, 18, 15, 12, 9 carat, or even a lower quantity of gold, it is put into what is called a pot and melted on a furnace. This furnace can be heated by gas, by charcoal, or by coke; it could be by electricity, but the application is not sufficiently perfected to be used for a goldsmith's furnace yet; however, it will, I hope, be so soon.

When the gold is absolutely fused—and the greater the proportion of gold in the mixture, the greater the heat required to fuse it—it is poured into a mould called a skillet, and allowed to cool; when cold it is ready for flatting, which is done by rolling it between two heavy steel rollers. It depends on the intended use how thin the metal is rolled. There are gauges for this, like those for wire and sheet metal.

If the gold is wanted for gem rings, it is left thick and cut with shears into slips. I mean for good work. For common work done in Birmingham and Sheffield (and, I am sorry to say, in London, too), the settings for the stones are stamped out by machinery, and the claws bent over the stones, instead of, as in the best work, the claws being cut to the stone. The goldsmith will, for himself, further flat the gold in small mills, if it be necessary for his work. He will also fuse small

* A lecture delivered before the Society of Arts, London, February 27, 1894. From the *Journal*.

pieces or cuttings into the shape he desires, on what he would call "a coal," really a long piece of charcoal hollowed in the center, for the very old terms are still used in work rooms (charcoal was called "coal" long before "sea coal" was burned in the Chapter House, at Westminster, where the first fire was made of what we now call coal, of which we have any record; but this by the way).

Having arranged his gold in the rough, the workman proceeds to hammer it more nearly into the required shape, if it be for a ring with stones in it. After he has fused a thick mass for the head, he hammers a long straight piece (cold work, you see), then with his pliers he bends it round to get it roughly into shape, then he files the inside to get it smooth enough to make it the desired size to fit the finger, it is then filed and scaupered into shape, carved and clawed. The ring is soldered together at the back, it is polished with sandpaper, with "water air stones," which look very much like slate pencils, and with hard wood. The little claws are "threaded out," *i. e.*, polished with whitey brown thread, on which a little rouge has been rubbed. Sa far, all work goes through these processes, whether it is to be finished bright or colored. The last thing done is setting the stones.

Now, you will perceive that the gold was alloyed and melted into an ingot; so far heat was used, but for the flatting no fire is necessary. Tradition—and all tradition has a basis of truth—says the gold the ancients made the ornaments for the dead from was beaten into the thin plates from which the wreaths, etc., were cut between thin layers of leather and beaten with a very heavy hammer. Gold beaters now beat their gold between thin leaves of vellum. The thin gold used by the ancients for their funeral ornaments was of the same degree of fineness as that beaten now, which has about one part alloy, either silver or copper, to twenty parts of pure gold. The alloy diminishes the malleability, so the inducement is only small to deteriorate the quality, for gold leaf is sold by size and not by weight.

Now, the gold is cast into oblong ingots, about $\frac{3}{4}$ of an inch thick and wide, and each weighing about 2 ounces; this is flattened into a ribbon about $\frac{1}{100}$ part of an inch thick, then annealed or softened by heat and cut into pieces about an inch square; 150 of these are put between vellum, each piece of gold in the center of a square of vellum; another and another added, until a pile of 150 is made. This pile is inclosed in a double parchment case and beaten with a 16 pound hammer. The elasticity of the packet lightens the labor, as the hammer rebounds with each blow. The beating is repeated until the inch pieces are spread out to four-inch squares; they are then taken out, cut into four pieces each, placed this time between gold beaters' skin, and hammered as before, but this time with a lighter hammer. They are again quartered, and again hammered, thus producing 2,400 leaves, having an area of nearly 200 times that of the ribbon, and a thickness of $\frac{1}{200000}$ of an inch.

The soldering of the ancients was something very marvelous. Castellani is of opinion that, so far as gold work was concerned, they were better chemists than we are, and used solvents with which we are unacquainted.

The delicate grain work with which the Etruscan covered large surfaces is not easy to imitate. Here is a little piece roughly done, as an illustration; but there are few men who can do it now.

For a long while after the Etruscan gold work came to light, it was found impossible to copy the color of the gold, but now we can get it exactly by putting the proper proportion of common salt, saltpeter and alum in a flat-bottomed pot with distilled water, and heating to 212° Fah. This mixture is not pretty to look at, for it boils up a pale, sickly, greenish color.

The gold work to be colored should not be of less than 18 carats fine. It is hung from a platina ring with either platina wires or horsehair; there should be plenty of it, for the greater the amount of gold to be colored, the better the color of each article. The work, having been properly cleaned, is dipped into the boiling mixture, taken out, dipped into clean boiling water, dipped into the color pot again, again washed in hot water: about the third dip the rich bloom of color comes. Much more washing is still necessary before the work is ready to dry in hot boxwood dust, after which it is scratch-brushed. This is a scratch brush: the hole in the center fits on to the mandrel of a foot lathe, the article to be finished is held against the revolving brush in the hands of the workman. Now, nothing is so good to feed the scratch brush with as *beer;* this drops on the revolving brush from a little hole in a small tub fixed over the lathe, so that the beer drips on the brush as it revolves.

If this scratch-brushing is done by a clever operator, 18 carat gold has the beautiful bloom of the best Etruscan work; this is the very reverse process of gilding, for in gilding pure gold is added to and spread over the surface, while, in coloring, the alloy is eaten from the surface, leaving only pure gold visible. We know that the Japanese derive some of their ideas from the most crystallized of all old time peoples—the Chinese. Shall we ever have a more intimate acquaintance with their inner life and their old tradition, and find out whether the Japanese "pickles," as their coloring mixtures are sometimes called, are made from early traditions of the craft—traditions of the knowledge emanating from the Hindoo Koosh, but lost lore to European nations? As to the processes, by which the result was obtained in the old work, we have little to aid us; but we may safely say that whenever the work was done, in prehistoric times, in Egypt, in Assyria, in the cities of Italy occupied by the Etruscans, in Greece, in Rome, or nearer our own time, in Florence, it was not the working that was so very different from our own; it was the almost intuitive feeling for art that made the gulf between the goldsmiths' work in the past and to-day.

In very early times mechanical aids to repetition were adopted; the Greeks used dies for the little amphoræ they were so fond of hanging round their necklaces; no doubt, also, they made cutters for the pateræ so often seen in Greek and Græco-Etruscan work. I do not suppose they had any better equivalent for a monkey press than a sledge-hammer, but they had that. Yes; the old craftsmen beat, flatted and annealed their gold; they drew wire, they twisted it, they screwed it, they did *repoussé* work, they engraved the most beautiful intaglii on their gold rings; they knew how to prepare their work for the inlaying of stones, of which enameling was only an imitation, and in the earliest times they understood Cloisonné and Champlevé enamels.

At the present time all these things are done, but we do not often have artists to make the dies, and we depend too much on the dies; it is the curse of cheapness that spoils our work. Now, necklaces, brooches, bracelets, are made by the dozen, all alike. It spoils the work, and it spoils the workers, for instead of a man being able to make all usual trinkets right through himself, it is found cheaper for a foreman to give so many articles, all to be alike, to one man, who takes so many boys under him. These boys are only taught to do one portion of the work, some only learning to make snaps, others only joints, others only tongues and catches. In after years what is to become of these lads? The men who teach them can only make one thing; a broochmaker can only make brooches, and so on, and of the separate parts of that thing he teaches so many boys to make one part only; not one of them could put them together from anything taught in their factory, and but few lads have the wish or the application to learn more than they are taught. No, it was a better time when the old system of apprenticeship prevailed, and it was to the masters' interest to teach a boy to be a thorough good workman. When the goldsmiths who have been apprenticed are all dead and gone, where will the craft be then? The boys "taken on" will not be of any use, indeed, many of them now finding it impossible to get their bread with the knowledge they have acquired, go as soldiers, so the little they have learned is lost.

If technical schools would only supplement proper apprenticeships instead of attempting to be a substitute for them, they would do much good. Reading all about an art for a year is not so useful as working with others who know and exercise it for a month. Practice is necessary, has always been necessary, and will always be so. There is no art, craft or trade where constant practice is so necessary as that of a goldsmith. I know of several goldsmiths now whose technical work is quite equal to that of the best periods, but they have not only served their time, but have lost no opportunity since their apprenticeship expired of learning more about their work. Such goldsmiths are becoming more scarce every year.

In old times, in all ages and in all places there were two separate and quite distinct branches of goldsmiths' work. In the one case, the work done for the temples in honor of the cult of the people; in the other, for the houses of their chiefs and kings and for the adornment of their women; but it seldom happened, until at any rate comparatively recent times, that the secular work was done by the same craftsman as the work for religious purposes.

In the early Christian times there was little sacred art at all; the sect was too poor and despised; but, as Christianity gained noble and rich converts and the church became a power, it was only natural that their places of worship should become more magnificent than the heathen temples had been; and that much of the gold and silver of the temples should be melted up and remodeled for the service of the church.

How far back guilds of workers in gold can be traced I am sorry I cannot tell you, but we must suppose that the "Aurifices" of Rome formed a sort of corporation, for they erected a little triumphal arch in honor of Septimius Severus in the "Velabrum;" this arch does not bear any characteristic mark of goldsmiths or their work.

In Rome I have seen ancient inscriptions bearing these words: "Aurifex Aug.," "Aurifex Augustæ," "Aurifex Tib: Cæsaris," "Aurifex Liviæ," etc. The inscriptions prove that in and after the times of Augustus and Livia, emperors and empresses had goldsmiths in title attached to their service; similar inscriptions to these have been found in Britain, I believe.

The Gallic people have long traditions as goldsmiths, for records remain of goldsmiths in Limoges before the invasion of Julius Cæsar. The name of only one Gallo-Roman goldsmith has been preserved; it was Maburnius; he is mentioned in a will of the fifth century. Perpetua, Bishop of Tours, left the silver cross he used to wear and some other trinkets to a brother bishop, because he leaves the gold cross, etc., made by Maburnius to his church.

There were, and I hope still are, in the Cabinet of Antiquities in the Bibliothèque Nationale, Paris, the hilt of a sword in gold, gold bees and other objects, found in the tomb of King Childeric at Tournay, all of beaten gold.

One of the apprentices of Abbon, at Limoges, a youth named Eloi, was afterward one of the patron saints of French goldsmiths. St. Eloi, in his early days, was ordered to make a seat for the king—whether a saddle or a chair has never yet been quite decided—but he worked so diligently, so carefully and so honestly, that out of the gold intrusted to him he made two seats, without either being in any way defective, and he made the two in the time he was expected to make one; small wonder that he became minister to Dagobert the First, called "the great." Still, in the midst of all his grandeur and power, he worked as a goldsmith with his own hands, only assisted by his apprentice, Thillon, a Saxon.

In the time of St. Eloi there were three grades of goldsmiths—masters, companions and apprentices. St. Eloi founded a monastery at Solignac, where he taught the goldsmith's art to his monks. After the death of his master, Thillon became abbot, and continued the teaching of the craft. St. Eloi also founded a convent in Paris on a large piece of ground given him for the purpose, near where the Palais de Justice now stands. It was known as the Maison de Madame St. Aure (Aurata), from a virgin that came to Paris from Syria preaching the Gospel in Hebrew to convert the Jews. Perhaps she was chosen as first abbess on account of her name, for St. Eloi had his favorite art taught here also; and the convent became the center for gold embroidery for church work. The nuns were celebrated, not only for their exquisite work and the beauty of their designs, but also for the excellence of the gold thread they manufactured, which was purchased from them by all the world. The old accounts of this convent rather lead one to suppose that vessels and crosses for the service of the church were also made here; but I am not sufficiently sure that the nuns made them to cite those nuns as women goldsmiths.

In Paris, during the reign of St. Louis, strangers were allowed to work as goldsmiths, after they had lived for a year and a day in the quarter of the Pont au Change or Grand Pont. If they were approved as craftsmen and good fellows—for all this time they must have been under the observation of the masters of the craft, who certified them to be respectable men and good workmen—they had to pay a tax to the king, according to the value of the custom they had; there was one Richardin, the enameler from London, who paid an impost of 3 sous; Robert, the Englishman, who paid an impost of 12 sous; and many other names of foreigners are recorded as having practiced the craft at that period in Paris.

In the eleventh century the monk Theophilus, who wrote on many arts, wrote a treatise on gold work, which, when all the odd superstitions about the preparation of gold are eliminated, evinces a knowledge, and a practical knowledge, too, that would be hard to excel now.

Theophilus, whoever he was, and from whatever country he came (for these two details are not recorded, and the theory that he was of English birth never has been either proved or disproved), was a thorough master of all branches of the art; and a translation of his work will do more to help an amateur in his studies than any of the so-called technical hand books ever written.

The treatise commences by describing how the factory—*fabrica*—should be built. He recommends that it should be large and spacious, should have a wide window, with a good light; he directs that there should be planks put round the table where the workers sit, to catch the pieces of gold that may fall in working. To the left of the worker a furnace must be built, of well kneaded clay. He must have bellows, anvils, hammers, pincers, nippers, draw plates, screw plates, files, irons to scoop out the gold, to scrape it, to grave it, and to cut it. These "irons" are the great-grandfathers of our scrapers, split stickers (*spelzsticker*), bull stickers, etc., used now. He does not mention "skins," always attached to the board nowadays, but probably the workers then wore leather aprons, which answers the same purpose.

This monk knew all the ordinary work. He tells how to begin and to finish cups for the altar, niello work, enameling, and almost all the details of every branch of the craft; and all that he describes he did with his own hands, even to the building of the furnace. How many craftsmen are there who could do this now? Many of them can only do one thing, and that indifferently well.

Theophilus taught that a lad must be apprenticed for not less than eight years; then that another term was desirable, and that if all that could be learnt was to be acquired, a further term of pupilage must be spent, to make a first rate master. Theophilus contended that it was necessary to be an apprentice for twenty-one years! In the Bibliothèque Nationale there is an engraving of Etienne Delaulne's workshop, done by himself. Etienne Delaulne was better known as "Stephanus." This engraving has been much copied, and the copies much used; it has even come down to be a frontispiece in a retail trade catalogue, but it is so very interesting that I asked my husband to prepare a slide for me from it, in order that I might point out to you the resemblance between a factory some five hundred years ago and one of the present day.

The Dictionarium of Magister Johannes de Garlandia gives some quaint accounts of customs in the trade, such as the rule that no master should be permitted to take a new apprentice before the one already bound was half out of his time, and that no master goldsmith should be permitted to take more than one outsider as an apprentice under any circumstances (by an "outsider" he means a lad, the son of a foreigner, or of a father who followed a calling other than that of a goldsmith).

The author of this dictionarium was of the noble family of Garlande; he followed William of Normandy into England. Both John Garlande and his Norman master were great patrons of the art; and I think Garlande could hardly have written as he did unless he could have worked himself, as well as describe the methods of work.

In all that concerns our subject the English were never far behind; there are Saxon jewels of great interest in the British Museum, and in the Ashmolean Museum there is King Alfred's jewel, a drawing of which will be shown presently; at any rate the commercial spirit of the English was always manifest. It is related how English treasure helped the Abbe Suger out of a great difficulty. I should remind you that the Abbe Suger was abbot of St. Denis, and minister to Louis VI. in the twelfth century. Suger had prepared a magnificent gold crucifix and other ornaments for his abbey church, but for a long time after they were ready he could not obtain the stones he required to finish them, until when he began to despair three monks from England came to him to sell the jewels removed from the table cups of our Henry I., jewels that the king's nephew, Thibaut, Count of Champagne, had given to various convents to procure indulgences and prayers. How the jewels came into the hands of these three monks I am unable to tell you, but history says that the Abbe Suger bought from these men, for a sum equal to £400 of our money, jewels that were at the time of priceless value. The crucifix was melted in 1590 by the leaguers.

In the eleventh and twelfth centuries much gold was used in the manufacture of cups and decorations for sacred purposes; probably that is why so few of them remain now.

The gold on the Paliotto executed for that very interesting church in Milan, St. Ambrogio, by the goldsmith Wolvinus, was valued at 280,000 gold crowns; it is a most beautiful piece of goldsmiths' work, enriched with cameii and intaglii, precious stones and enamel. Quintillian justly observes, "*Ars summa materia optima melior*," and the value of the exquisite design and arrangement of this work is far above the value of the material employed, yet the value is, in this case, so far above price, that there is an additional reason for being glad it is still preserved to us. Count Blazini told me how nearly it was lost when Milan was entered by the famished soldiers of

Napoleon, and how it was saved by the adroitness of a priest, who knew that a small portion had either been stolen or lost, and that the vacant space had been supplied with a good imitation in copper gilt. This little accident was only known to a few of the priests, the outer world knew nothing of it When the soldiers entered the church, the priest advanced to them asking what they wanted. He was rudely answered, "The gold altar case and the gems set in it." "Alas!" he said, "would that we had a gold altar, its value would supply the wants of many; it is this gilt Paliotto," he continued, "that you must mean. Look! I will show you the gold." And he coolly broke away the restored copper gilt portion, saying, "Do you think, if the gems ever were real, those here now are better than the copper? No, poor fellows, it is not in this bare, half empty, poor old church that you will find treasure; go seek it elsewhere." And they went without touching the Paliotto.

There is much to be said about art of the kind in our own and other countries, but there are some illustrations to be thought of, and with your permission they shall now be shown and described.

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The paper was illustrated by a series of lantern slides, taken from fine historical examples of jewelry in the Gold Ornament Room of the British Museum, and other great national collections.

Slide.

1. Assyrian gold cup of beaten work, very sharp and characteristic; one of the finest old pieces of work now extant.
27. One side of another missal cover, from collection Royal Irish Academy.
28. Shrine of St. Patrick's bell, from collection Royal Irish Academy.
29. Cross of Aberlemno.
30. Ornaments from Historical Museum, Munich.
31. Cellini pendant.
32. Gold and enameled mediæval cup.
33. Cover of above.
34. Dagger and sheath (Holbein).
35. Venetian cross, from house of Marco Polo.
36. Workshop of Etienne Delaulne (better known as Stephanus) from the engraving by himself in the Bibliothèque Nationale, Paris.

37 and 38. From the Worcester casket design by Mrs. P. H. Newman.

39. Mounting of opal cameo, designed by Mr. P. H. Newman.
40. Enameled brooches, designed by Mrs. P. H. Newman.
41. Gold brooch, designed by Mr. P. H. Newman.

## THE SMALLEST BOOKS IN THE WORLD.

THE *Intermediaire des Chercheurs et des Curieux* asked, about two years ago, whether any volume was known of still smaller dimensions than a "Petit Paroissien de l'Enfance," printed without date by Firmin-Didot, and which is 1·12 inch in length by 1 inch in width. In answer to this question, we made known in *La Nature* a few volumes of smaller dimensions than the above named, and certain of which are in our possession. The smallest of the booklets mentioned by us, "Le Réveil-Matin," an almanac for 1871, measures but 0·75×0·5 inch. A bookseller of Paris having at that time assured us that he had seen a still smaller booklet, we in turn asked our readers, What is the smallest book in the world?

At the time of writing our article, we were merely able to name the collection of a Parisian amateur, Mr. George Salomon. Since then, we have had the good fortune to visit this wonderful collection, and we really think that we found therein the smallest book or books that have ever been published—the microbes of the book! It comprises about seven hundred volumes published in France and other countries upon all subjects, from the most trivial to the most serious.

In order that a volume may be judged worthy of figuring in the collection, it must not exceed certain dimensions, a maximum size. Of course, concerning a minimum, there is no question. The maximum size (judge of the surprising effect of this liliputian library) is "La Fontaine," printed in microscopic characters by Laurent & Derby in 1850, the justification of which, that is to say, the length and width of the printed page, measures 2·16×1·32 inches. This is a type known to bibliophiles as 64mo, and classified in the National Library in the category of "dwarf books." As for this, we shall hereafter specify the dimensions of the book by its justification. Such determination appears to us more comprehensible than that of size for books so small, and it is more exact than the measurement of the page, which may have been cut more or less.

Around "La Fontaine," ranked as a giant, are found all the little works that may be considered as the classics of microscopic printing: "Les Œuvres d'Horace," 1828, from the press of Henri Didot (1·98×1·2 inch); "La Rochefoucauld, Maximes et Reflexions Morales," 1827, from the same press (1·68×0·84 inch); "De Imitatione Christi," Tross edition, 1858 (1·84×1·2 inch); the same from the press of Mame, 1862 (2×1·24 inches); "Le Rime di Petrarca," Venice, 1879, 2 vols. (1·56×0·96 inch); "La Divina Comedia di Dante," Milan, 1878, 1 vol. of 500 pp. (1·52×0·88 inch); etc., all bound with great perfection.

In the midst of numerous small books in Latin of the seventeenth and eighteenth centuries, we remark in a pretty cover of old morocco, a "De Officiis" of Cicero published at Amsterdam in 1625; a small medical work, "Hippocratis Coi Aphorismi, ex Officina Plantiniana Raphelengi," 1617 (1·8×1·2); etc.

History and politics are likewise represented. Let us mention "La Constitution Francaise," etc., Paris, from the press of the Typographical Literary Society of l'Estrapade, No. 10, 1792 (1·6×1·56 inch); one of those small charters distributed in so great number and so difficult to find, "Etrennes Francaises ou la Charte Constitutionelle octroyée par le Roi au Peuple Francais," Paris, from the press of E. Jourdan, 1821, in its original paper cover (2·16×1·2 inch); and a constitution of Holland in Dutch, from the press of Joh. Enshedé en Zouen, Harlem, 1861 (1·56×1·2 inch), remarkable by the fineness and sharpness of the characters. We find further an epitome of the history of Holland, in Dutch, published at Amsterdam by Crajenschott, 1753, in 2 vols., bound in old calf and measuring 1·4×0·68 inch. They have respectively 146 and 266 pages and contain a large number of extremely fine figures of the principal persons and epi-

FIG. 1.—MINUTE FRENCH BOOK (Actual size).

FIG. 2.—OTHER MINUTE FRENCH BOOKS (Actual size).

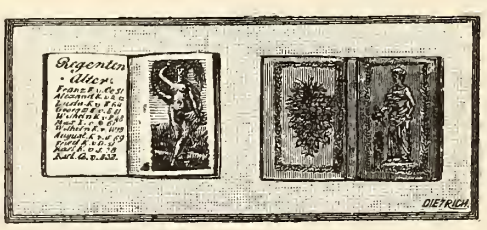



FIG. 4.—MINUTE GERMAN BOOK (Actual size).

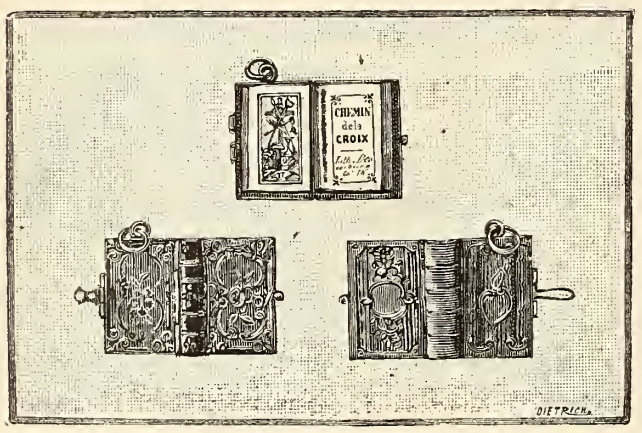



FIG. 5.—MINUTE FRENCH BOOKS (Actual size).

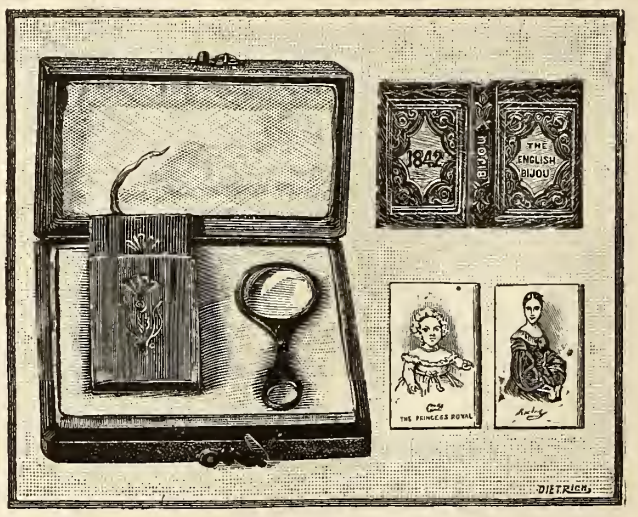



FIG. 3.—MINUTE ENGLISH BOOKS (Actual size).

2. Funeral wreaths (Etruscan).
3. Bracelet, with *repoussé* figures, fibulæ, etc.
4. Etruscan ear rings, ornaments to be sewn to garments, etc.
5. Etruscan necklace, heads of "IO," etc.
6. Etruscan necklaces, pins, etc.
7. Archaic Greek.
8. Archaic gold cup, etc.
9. Greek necklace, etc.
10. Greek necklace from island of Melos, etc.
11. Later Greek necklace, in form of stars, and Herculean knot in carbuncles.
12. Roman "marriage" brooch.
13. Early British torques.
14. Head ornaments, engraved; early British.
15. Byzantine cross, with Lord's prayer in the Cyrilic character.
16. Byzantine cross, with emblems of the "Passion."
17. Byzantine cross, and cross from Rheims Cathedral.
18. Anglo-Saxon ornaments.
19. King Alfred's jewel.
20. Reliquary from Royal and Imperial Treasury, Vienna.
21. Crown of Charlemagne, from Royal and Imperial Treasury.
22. Sword of Charlemagne, from Royal and Imperial Treasury, Vienna.
23. Arm bone reliquary, from collection Royal Irish Academy.
24. Cross of Corg, from collection Royal Irish Academy.
25. Fibulæ, from collection Royal Irish Academy.
26. Two views of a missal cover, from collection Royal Irish Academy.

Among the numerous religious works, there is a group of exquisite little primers and Bibles of the seventeenth and eighteenth centuries. Let us mention some of them: Two volumes bound in antique calf giving a series of 264 very small copper plate engravings on the Old and New Testament by two female artists, Christiana and Magdalena Kussler, who lived in Switzerland toward the end of the seventeenth century (1·68 × 1·36 inch); two smaller volumes (1·36 × 0·72 inch) of 84 and 83 very delicate engravings on the Old and New Testament, published at La Haye toward the middle of the seventeenth century; a catechism in German, of 1611, measuring 1·68 × 1 inch, in a binding of antique calf, with a small clasp of chased copper of the epoch. A curiosity among curiosities is the Siamese twins of books, one entitled "Catechismus Handlung" (187 pp.) and the other "Christlichen Haussard" (191 pp.) printed at Nuremberg in 1666 (1·24 × 1·24 inch). Bound in richly ornamented calf, they have one of the sides in common, and open in opposite directions.

Among the primers in French, let us mention "Heures Nouvelles dédiées à la Noblesse," Paris, Valleyre, Jr., 1781, 216 pp., with a calendar for 1783, bound in antique calf with stamped ornaments (2·08 × 1·2 inches); "Heures de Cour Contenant les Offices," etc., Paris, V. Cuissart, 1783, 252 pp., bound in antique calf (1·68 × 0·92 inch); "Heures de Cour Contenant les Sept Offices," published by S. Chardon in 1682, bound in calf with silver corners and clasps of the epoch (1·52 ×

0·88); "Heures à la Cavalière," Paris, T. de Hansy, 1751, 223 pp., old green morocco binding in a case of antique calf (1·32 × 0·8 inch); "La Sainte Bible mise en vers," by J. P. J. du Bois, at La Haye, P. Servas, 1754, 192 pp., several engravings (1·44 × 0·8 inch), old blue silk cover inclosed in an antique calf case entirely covered with stamped ornaments; "Le Reveil de l'Ame," Annecy, 1784, with 56 pp. (1·64 × 1·16 inch), in an old silk cover ornamented with golden threads and spangles.

Let us stop to admire, in their elegant covers of old morocco, several Bibles published at London during the first half of the eighteenth century and measuring 1 × 0·8 inch; and a German volume, "Begriff Christlicher Lehre," 1778, 64 pp., 0·88 × 0·44 inch, in bright green boards with silvered ornaments. In the board bindings of the epoch, often covered with figures, and as fresh as if they had just come from the hands of the stitcher, there is a full series of books designed for children or the gentler sex, and filled with pretty figures, charming as regards printing and subject, and almost all printed by the Didots during the first half of the present century.

Here we have a series of pocket song books elegantly bound in morocco, showing in a manner, by the difference between the printing and engraving at different epochs, the grandeur and the decadence of song in our country. The titles are suggestive: "Le Chansonnier joyeux de l'Amour et du Lit, à Cythère" (2 × 1·6 inches): "Chansons joyeuses et de Table," by Piron Colle and others, Paris, 1816 (2 × 1·7 inches).

The almanacs are of a more modest turn. There is here a series as rare as it is complete, extending almost uninterruptedly from 1790 to 1818. These books, published by Jubert, Janet, Le Fuel, Marcilly and others, measure, nearly all of them, 2 × 1·4 inches. With the calendar, they contain a selection of pretty songs and charming figures: those of the revolution are by Dorgez. Let us mention in particular a patriotic and gallant almanac of 1792: "La Civiologie portative ou le manuel des Citoyens." The frontispiece is a flory globe surmounted by a Phrygian cap and surrounded by tricolored flags. Viscount de Savigny of Moncorps, a learned bibliophile, and owner of one of the finest collections of old almanacs, has given some extracts from this in a recent study upon the most remarkable almanacs of the revolution. Mr. J. Grand-Carteret, a well-known art critic, has reproduced its frontispiece and its twelve engravings by Dorgez in the bibliography of French almanacs, which ought soon to appear.

All the almanacs just mentioned are bound in silk enriched with golden threads and spangles and colored embroideries usually representing the attributes of love, or in richly ornamented morocco, or sometimes in pretty boards of the epoch. The interior, lined with silk, with mirrors and a little pocket, is of the most elegant character. The silk cover of an almanac for 1774 bears a painting representing persons gazing at a boat flying with its pilot, a grand ancestor of the balloon. A few Dutch almanacs of the middle of the eighteenth century are got up in the style of our own. Their engravings and covers must have come from the hands of our artists. They measure for the most part 2·2 × 0·88 inches.

Certain English almanacs of the end of the eighteenth century and the beginning of the present are interesting by reason of the information and engravings that they contain, as well as by their stamped or mosaic morocco covers. Those of the London Almanac Series published for the Company of Stationers measure 2·2× 1·12 inches.

We reach by degrees those tiny volumes that we formerly gave as the smallest books known, but which, as we shall see, have to compete with smaller ones still. There are here nearly two hundred of them, exhibiting their backs of gold, silver, morocco, silk or cardboard of the epoch.

In gold or gilded silver charms, they were formerly attached to chatelaines. This compartment of minuscules *par excellence* comprises a dozen prayer books, and a Constitutional Charter of 1814 measuring 0·88× 0·5 inch, with an outer title of 68 pages. It is one of those rare dwarf volumes in which one does not sing of God, love, or gayety. In Fig. 1 we reproduce its title and its cover, which is of gilded and figured cardboard. Then comes a series of French song book almanacs published between the years 1769 and 1849 by Boulanger, Jubert, Janet, and others. But few years are wanting. The largest of the collection measures 0·95×0·55 inch, and the smallest from 0·7 to 0·75 × 0·45 inch.

In Fig. 2 are shown, among the booklets of this type, "Le Chansonnier Lilliputien," for 1820, entirely engraved, and in its boards of the epoch, and another song book in a morocco case in the form of a book.

The foreign minuscules are much superior to the French in the distinctness and fineness of the printing and engraving. At the beginning of the century, Austria published a wholly engraved oblong almanac without figures, "Mignon Almanach Wien," by Jos. Riedel, etc. The title occupies the first two pages, and the page measures 0·8×0·6 inch. These almanacs have pretty ornamented morocco covers, 0·84×0·68 inch, and are inclosed in cases of morocco or of gilded silver forming charms. The English almanacs published at London toward the middle of the present century under the title of "The English Bijou Almanac," measuring 0·55×0·4 inch, must be classed in the front rank of the series of booklets for the extreme fineness and beauty of the engraving of the text and figures.

It is impossible to reproduce here, in print, their text, or even their title, so microscopic are the characters. In Fig. 3 we show one of these pretty almanacs partly hidden in its cardboard case of the period, and lying in the casket in which it was sold along with a small magnifying glass mounted in tortoise shell. We show in the same figure, of actual size, the morocco cover of the almanac of 1842. In order to give an idea of these almanacs, let us notice some of them in detail:

"Schloss's English Bijou Almanac for 1843, poetically illustrated, by Miss Mitford (author of 'Our Village')," London, published by A. Schloss (fancy stationer to Her Royal Highness the Duchess of Kent), 12 Berners Street, Oxford Street. Before this title page come two pages of introduction in verse and an engraving representing the Prince of Wales. Within there are five other portraits, each accompanied with two pages of stanzas in honor of the person pictured. We see in succession Frederick William, King of Prussia, the Princess of Orleans, Samuel Rogers, Adelaide Kemble, and Ludwig Dobler. Then come the calendar and some information as to the royal house, the ministers, etc., in all forty-seven pages. The almanac of 1837 contains a dedication to the Queen, and seems to be the first of the series. Among its figures there is a charming portrait of Malibran, accompanied with stanzas and four pages of a rondo in microscopic music with words. In Fig. 3 we reproduce, of actual size, two of the engravings of the almanac of 1842, representing the princess royal and Rachel, the tragedienne.

There are some almanacs smaller still, published between the years 1817 and 1840 by the Lithographic Institute of C. F. Muller, at Carlsruhe, and that measure but 0·55×0·35 inch. As in the preceding, the characters are so fine that we can reproduce here neither their text nor title. They contain from 26 to 28 pages and from 6 to 12 engravings. Fig. 4 shows, of actual size, the cardboard cover, one of the engravings and a page, with slightly enlarged characters, of the almanac for 1819. The almanac for 1831 bears upon one of the sides of the cover a portrait of an Algerian man and on the other an Algerian woman. Algeria was then all the rage. Within, there are charming portraits of Sontag, Paganini, Franz, Napoleon and of Hussein Pacha, the last Dey of Algiers, etc. On the sides of the cover of the almanac for 1832 there is a portrait of Mohammed II. and his favorite, and, within a series of Turkish personages. The almanac for 1834 contains the portraits of Gen. Jackson, Frederick William, Prince Royal of Prussia, and Otto, King of Greece. Then comes a series of tales, with an outside title occupying one page: "Blumen, Deutung Componirt und auf Stein ausgefuhrt von G. Nehrtich." Through the microscopic text are found scattered numerous vignettes of rare fineness. The other volumes of this series are of a piece with those that we have just sketched in a general way.

As small as these Carlsruhe almanacs are, they are still not the smallest of this unique collection. The minimum size of the library is furnished by a Chemin de la Croix and a Paroissien (prayer book) that measure but 0·55 × 0·24 inch!

Fig. 5 shows, of actual size, the gilded silver, delicately chased charms into which they are set, and the title and one of the engravings of the "Chemin de la Croix," which contains 119 pages and numerous vignettes. After such infinitely small products of the press, let us draw the curtain. Have we not shown the smallest books in the world?—*G. Tissandier, in La Nature.*

## STEREOCHEMISTRY, OR CHEMISTRY IN SPACE.

THEORIES become modified and improved in measure as the needs of science increase and its exigencies become more imperious.

At the origin of organic chemistry, which is nothing but the chemistry of carbon, and which now, let us say by the way, comprises the study of nearly a hundred thousand bodies, one was content to represent compounds by crude formulas in which letters affected by exponents indicated the relative proportions of the atoms constituting the molecules. Methane, for example, was written $CH_4$, the letter C representing the atom of carbon, and the letter H the atom of hydrogen.

But it was very quickly seen that such formulas could not account for the differences existing between certain properties of bodies that had, nevertheless, the same centesimal composition, or, that, in other words, were isomeric.

Thus, acetate of amyle has for rough formula $C_7H_{14}O_2$. It is produced by the action of acetic acid ($C_2H_4O_2$) upon amylic alcohol ($C_5H_{12}O$).

Propionate of butyle, likewise, has the formula $C_7H_{14}O_2$. It is a product of propionic acid ($C_3H_6O_2$) and butylic alcohol ($C_4H_{10}O$). In both cases one molecule of water is eliminated.

Upon analysis, acetate of amyle and propionate of butyle will furnish the same figures. Yet their boiling point and their density do not agree. These two bodies are, therefore, not identical. In the internal arrangement of their molecules there is something that we cannot determine with certainty in the present state of science, but which causes them to behave differently, not only from a physical, but also from a chemical point of view.

In fact, the acetate of amyle is capable of regenerating acetic acid and amylic alcohol; and so, too, the propionate of butyle is capable of splitting up into its constituent elements. It is, therefore, natural to think that in these two bodies the radicals of amylic alcohol and of acetic acid, on the one hand, and of propionic acid and butylic alcohol on the other, unite in preserving respectively their primitive molecular grouping. Hence their formulas will be able to be written: $C_2H_3O_2$, $C_5H_{11}$ for acetate of amyle, and $C_3H_5O_2$, $C_4H_9$ for propionate of butyle.

This first step taken, it was desired to go further. Gerhardt devised typical formulas that rendered evident, in the molecule, the groupings of atoms that preserved themselves intact in reactions. The impossibility of explaining with such formulas the reactions of the polybasic acids studied by Graham, Wurtz and Liebig, and of the polyatomic acids by Wurtz and Berthelot, made one think of doing better.

It certainly took a long time to discover the truth. It required the splendid work and persevering sagacity of Cahours, Kolbe, Frankland, Wurtz, Kekule, and Couper to reach the suspicion in the first place and then to render evident those mysterious attractive forces that manifest themselves in the atoms, and that are called valences.

It is to Kekule and the unfortunate Couper that is due the honor of having clearly established the quadrivalence of carbon, that is to say, the presence of four centers of attraction invariably existing around each atom of it. Wishing in nowise to prejudge as to the form of the atom or as to the nature of the forces acting and as to their orientation, Kekule contented himself with representing the atom by a letter and the valences by lines arranged regularly around such letter.

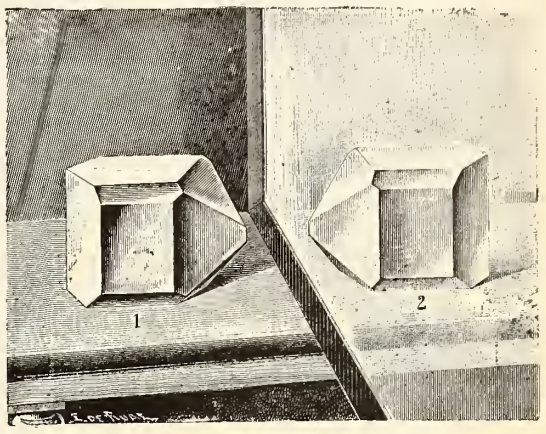



FIG. 1.—CRYSTALS OF DEXTRO AND LEVO TARTARIC ACID.

At the extremity of each of the lines another letter figured the atom that saturated a valence.

The atom of carbon became then:

and methane was written:



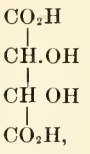
Kekule's plane formulas served well to explain some isomeric bodies that were, until then, incomprehensible, and to cause to be foreseen the existence of numerous bodies that chemists succeeded in preparing.

What more brilliant confirmation could the hypothesis of the quadrivalence of carbon have received?

Meanwhile, chemistry was progressing, and a day came in which, before certain facts, plane formulas had to remain mute. It was evident that they were only a makeshift. It would be impossible to represent upon a plane, except in projection, what takes place in space.

Imbued with this idea, and already enlightened by the labors of Mr. Pasteur on the tartaric acids, Messrs. Le Bel and Van't Hoff created stereochemistry, erecting in space molecular edifices which, although hypothetical, threw, nevertheless, an entirely new light upon chemistry.

Tartaric acid,



is capable of exhibiting itself under four different isomeric states. What especially characterizes these isomeric bodies is their action upon polarized light. One turns the plane of polarization to the right, and is called *dextrotartaric acid.* Another turns it to the left to the same degree, and is known as *levotartaric acid.* The third, which is optically inactive, is a combination of equal parts of the dextrotartaric and levotartaric acids, and is called *paratartaric* or *racemic acid.* It is capable of being reduced into its constituent elements. Finally, the fourth is not reducible, and is called *inactive tartaric acid.*

Mr. Pasteur had the honor of discovering the cause of the singular phenomenon exhibited by the dextro-

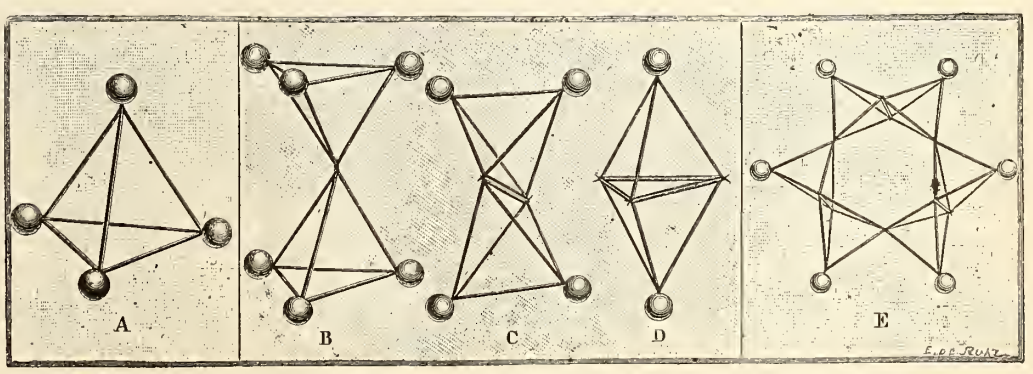



FIG. 2.—DIAGRAMS OF CHEMICAL MOLECULES.

A, methane; B, ethane; C, ethylene; D, acetylene; E, benzine.

tartaric and levotartaric acids. He considered it probably due to the asymmetry of the molecule that manifests itself on the crystals by the existence of hemihedral faces. The crystals of the first acid are hemihedral to the right, while those of the second are hemihedral to the left; in other words, the first are, in a mirror, the images of the second.

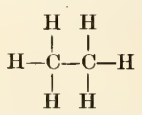
This is clearly seen in Fig. 1. The rotary power is, therefore, intimately connected with the asymmetry of the crystalline form.

Mr. Sarran has, in addition, shown by calculation that it suffices, in order that there may be an action upon polarized light, that the latter shall traverse an asymmetrical medium. The molecular asymmetry suspected by Mr. Pasteur has been rendered evident by the researches of Messrs. Le Bel and Van't Hoff. It is shown by the influence exerted upon polarized light by bodies having asymmetrical molecules.

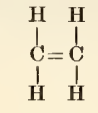
Messrs. Le Bel and Van't Hoff represent the atom of carbon by a tetrahedron. The valences are directed from the center to the four summits. In order to render this hypothesis, which serves as a basis to stereochemistry, wholly tangible, there are ordinarily employed small metallic tetrahedrons, to the summits of which may be fixed balls of different colors representing the atoms of the bodies capable of uniting with carbon.

Fig. A of our second engraving represents methane ($CH_4$). To each of the four summits of the tetrahedron is fixed a small ball, representing the atom of hydrogen.

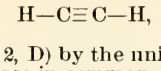
The simple junction of two atoms of carbon is represented by the contact of two summits. Ethane (Fig. 2, B) offers us an example of it:



The coincidence of two tetrahedric edges figures the double junction. Ethylene (Fig. 2, C) contains one of them.

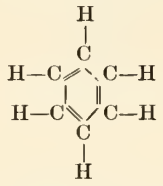


Triple junction, such as it exists in acetylene,



is represented (Fig. 2, D) by the union of two tetrahedrons having one base in common.

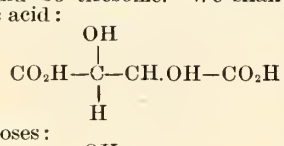
For benzine, the hexagonal formula of Kekule,



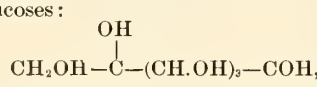
is represented by a grouping of six tetrahedrons (Fig. 2, E) offering alternately simple and double junctions.

Messrs. Le Bel and Van't Hoff have found that in order that there may be asymmetry, it is necessary that the four valences shall be saturated by four different atomic groups. All the known compounds possessing a rotary power contain at least one of these atoms of carbon, which they have called asymmetrical.

The bodies that have furnished the most striking proofs of this law are very numerous. To make a list of them would be tiresome. We shall be content to take tartaric acid:



and the glucoses:



in which we make evident one of the atoms of asymmetrical carbon.

Some compounds seemed, for a certain length of time, to form an exception to the common law. Thus, propylenic glycol and normal secondary amylic alcohol, which possess, however, one atom of asymmetrical carbon, are inactive upon polarized light. This is due to the fact that they consist, like racemic tartaric acid, of equal parts of dextro and levo bodies. If, as has been done by Mr. Le Bel, one of the two modifications be attacked with micro-organisms, the rotary power immediately appears.

Mr. P. Guye has desired to penetrate the molecular structure of bodies still more deeply than the two bold creators of stereochemistry. He has endeavored to ascertain mathematically the extent and direction of the rotary power, and has succeeded in doing so in a certain number of cases.

The new theory has already borne fruit. It is due to it in particular that it has been possible to explain the long obscure isomerism of malic and fumaric acids, and it is due to it, also, that Mr. Fischer has been able to make his remarkable researches upon the sugars.

As Mr. Friedel has well said, stereochemists do not conceal the fact that there is something of the hypothetical and, perhaps, a little crudeness in the method of representation that they employ. It is none the less true that it constitutes a step in advance of great importance, since it now accounts for delicate isomerisms of various orders, and, while permitting of coordinating all those that are known up to the present day, gives us only the number of them desired, and verified by experiment, in all cases in which verification has been made. It is, therefore, a wonderful working tool that has been furnished to chemists and at the same time a first conducting wire for the solution of the long since proposed problem of the relation between chemical composition and crystalline form.—*M. Otto, in La Nature.*

## NEW FORMS OF APPARATUS FOR ORGANIC ANALYSIS.

By Dr. JAMES LEICESTER, F.C.S., Lecturer on Chemistry and Metallurgy, Merchant Venturers' Technical School, Bristol.

I BEG to draw the attention of chemists to the following forms of apparatus which were made for me by Herr Hildebrand, of Erlangen, when working in the research laboratory of Professor Otto Fischer in 1888. I have used them in my research work during the past six years, and have found them a help in many ways.

The first of the small bottles, Fig. 1, is filled with

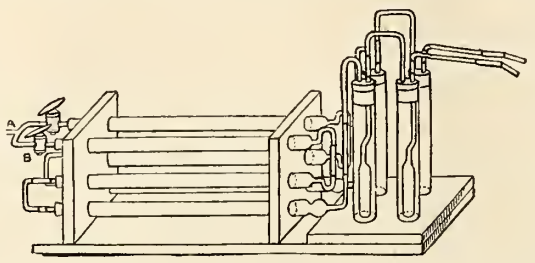


FIG. 1.—APPARATUS FOR DRYING GASES.

KHO solution; the second, with $H_2SO_4$ (conc.) The gas then circulates along the tubes and out at the end marked A. The tubes are filled in the usual way with KHO and $CaCl_2$, glass wool being placed near to the corks.

One side of the apparatus is connected to an air cylinder and the other to a cylinder of oxygen, the taps at B regulating which gas is passed through. The whole apparatus is fitted into a wooden stand.

The tube is filled in the usual way with a little glass wool at the top and has the form as shown in B, Fig. 2.

The long limbs are then sealed in the blowpipe, as shown in the lower figure.

A little piece of tubing passes into the bulb, as shown at A, and prevents most of the water from coming into contact with the calcium chloride. The whole apparatus is obviously air tight.

The form of glass wash bottle, as shown in Fig. 3, is useful in the case of substances that would act upon cork or India rubber. It is perfectly air tight, the gas bubbles through the circle of small holes at the base of A, and the bulb, A, prevents the liquid being drawn back.

The preparation of ethylene dibromide is conveniently performed in such a way, the bottle being filled with bromine.

Flasks of the form shown in Fig. 4 are very useful

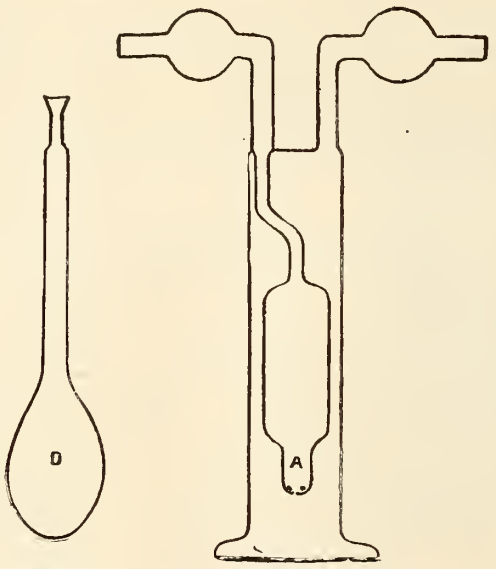



FIG. 4. FIG. 3.

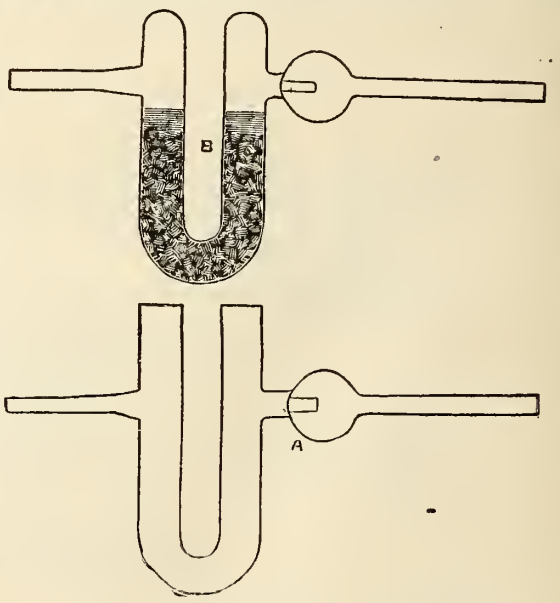



FIG. 2.—NEW CALCIUM CHLORIDE TUBE.

to keep the powdered and lump oxide of copper in for analysis. The flasks are strongly heated, and then the ignited oxide of copper poured into them, a copper funnel being used.—*Chem. News.*

## CHLORINE.

AT a recent meeting of the London section of the Society of Chemical Industry, Mr. F. Bale read a paper on the "Commercial Production of Chlorine by the Ammonia-Soda Process." The outline of the process is given in the following abstracted description of the various stages of the preparation. At the outset, ammonium chloride in powder is mixed with magnesia in powder, and heated in a series of retorts one above the other. The ammonia is evolved in a downward direction through exits at the bottom sides of the retort; the volatilization of ammonium chloride being thus prevented. The ammonium chloride powder is mixed by stirrers, revolving through the cylinders. When the ammonia has been evolved, superheated steam is passed through the mixture; passages being opened for it by the revolving stirrers; and a strong current of hydrochloric acid is evolved. The mixture above stated, after the ammonia is evolved, may be agglomerated by spraying with a solution of ammonium chloride, and stirring sufficiently to allow of the subsequent passage through it of superheated steam after the ammonia is evolved. The pure hydrochloric acid thus evolved is then dried by a current of strong sulphuric acid, descending a Glover tower, heated up in a Cowper stove, and passed into a Deacon furnace containing peroxides, made into marbles, and heated up to a temperature of 550° C., when a strong current of chlorine is evolved, which can be used at once for the manufacture of bleach. Two-thirds of the hydrochloric acid thus used become fixed as chloride, from which it may be removed as dilute chlorine by heated air, or as hydrochloric acid by steam. The hydrochloric acid so obtained is passed into another series of cylinders containing peroxides, and strong chlorine may be obtained as before. As a continuous process for the production of chlorine, the author proposed to mix the hydrochloric acid gas evolved, as above described, in proper proportions with air; both having been previously dried, and heated to the required temperature, when a continuous current of dilute chlorine is obtained of 40 per cent. or more, from the bottoms of the cylinders, and which is practically free from hydrochloric acid if the drying has been carefully done, and so may be used at once for the production of bleaching powder. Mixtures of hydrochloric acid gas, air and steam may also be used with more or less advantage, the gases evolved being afterward treated in separate cylinders, which for this purpose may be connected on the principle of the Hargreaves cylinders.

## QUANTITATIVE WORK FOR BEGINNERS IN CHEMISTRY.

By W. A. NOYES.

IN most chemical laboratories the work which is given to beginners is chiefly or altogether of a qualitative nature. In many schools and colleges the work begins with a study of the qualitative properties of a series of chemical elements and their compounds, chiefly of gases and metalloids. In other schools the students begin at once with the study of qualitative analysis. A large majority of students never get beyond this first stage, and it is safe to say that they acquire but a very slight knowledge of real chemical work. The work which is done in scientific and technical laboratories and in chemical factories consists almost entirely of quantitative analyses or of the preparation of chemical substances carried out in an accurate quantitative manner. Indeed, we are accustomed to say that the science of chemistry began with the use of the balance, and we all recognize the extreme importance of quantitative relations in most of our chemical work.

We must keep in view several objects in selecting the laboratory work for beginners. First, they should become personally acquainted with the appearance and properties of a number of the chemical elements and their compounds. The acquisition of a large amount of knowledge of this kind is desirable, but we may easily make the mistake of endeavoring to impart too much. A few topics exhaustively studied will prove of greater value than a superficial study of a great many. This is espeeially true of qualitative tests with solutions. A beginner can apply a great many such tests in a comparatively short time, but unless his powers of discrimination and of memory are very unusual, he will retain only a confused recollection of his work. A second object is to secure a training in delicate and accurate manipulation and in the use of different forms of apparatus. A third object is to fix in the mind of the student knowledge which may have been imperfectly acquired by watching the demonstrations of a lecturer or by the study of a text book. Some teachers carry this thought so far that they seem to imply that no knowledge of a topic can be really acquired by the student until he has demonstrated it by personal experiment. Indeed, I have heard some teachers contend that they would not allow a text book in the laboratory, but would have their students acquire all of their knowledge at first hand by their own experiments. Such a principle, if logically carried out, could never take the student beyond the stage of alchemy, for the student of to-day is no better able to develop a science of chemistry for himself than was the old alchemist. And if you direct his experiments in such a way as to develop and elucidate the science as it is now known, you have forsaken the principle just as much as though a text book were used.

It seem to me that such views arise from a mistaken conception of the real nature and purpose of laboratory instruction. After all, the method of personal experiment is a very slow and laborious method of acquiring knowledge. Only a very small fraction of our knowledge of a science, if that knowledge is by any means adequate, has been acquired in that way. It is true that the method is absolutely essential for beginners, and I do not think that any of us get beyond the need of it. The man who never uses a balance or handles a test tube will not for very long be a strong factor in the advancement of chemical science. But the method of laboratory instruction is essential, not because knowledge cannot be acquired in other ways, but because at the start the imagination of the student is deficient, and it is only by means of personal experiments of his own that he can acquire the ability to un-

derstand and appreciate the experimental work of others. The memory is also deficient, and the personal work on a subject may be of great value for that reason as well. But the things which we should endeavor to secure in laboratory instruction are, first, such an acquaintance with experimental methods as shall enable the student to thoroughly grasp the solid experimental basis of the science and give him the mental habit of referring everything back to the rigid experimental test; and second, the ability to do accurate and independent experimental work himself. No student can demonstrate for himself more than an infinitesimal number of experimental facts in comparison with the vast array of such material which has been accumulated.

If the principles which I have suggested are correct, we should endeavor to secure as thorough a knowledge as possible of experimental methods, and neatness and accuracy in laboratory technique rather than the illustration of as large a number of details as possible. These results can be secured more fully by a series of quantitative problems than by a large amount of merely qualitative work. I do not mean by this that qualitative work is not necessary and desirable as well, but for the beginners, especially, quantitative work is of more value. In order to make my meaning more clear I will give a few illustrations. One of the earliest problems that I give is the determination of the weight of a liter of hydrogen essentially by Regnault's method. A bulb containing about one half a liter and bearing a three-way cock is exhausted with a Bunsen pump and the residual pressure determined with a manometer. The bulb is then weighed, using a sealed counterpoise of nearly the same volume, then filled with hydrogen, temperature and pressure noted, and weighed again. The results obtained by careful work are usually one or two per cent. too high. A similar determination of the weight of oxygen gives results with a far smaller percentage error. The determination of the amount of oxygen in potassium chlorate by heating about a gramme of the salt in a small porcelain crucible placed within a second gives a good illustration of the law of constant proportion. The preparation of potassium perchlorate can be made to furnish a considerable amount of valuable instruction. The capacity of a bottle holding about two liters is determined, a calculation of the amount of potassium chlorate required to give oxygen enough to fill it when only the first stage of the reaction is used is made, and the experiment performed. Then the potassium chlorate and potassium perchlorate are separated and the latter is purified by crystallization. A study of the qualitative reactions which distinguish potassium chloride, potassium chlorate and potassium perchlorate is made and the tests to establish the purity of the last are applied. Finally a determination of the amount of oxygen in potassium perchlorate gives, in connection with the last problem, an illustration of the law of multiple proportion. I will give but one further illustration—the determination of the relative atomic weights of hydrogen, chlorine, and silver. A known weight of pure silver is dissolved in nitric acid, precipitated with hydrochloric acid and the silver chloride weighed on a Gooch crucible. In a dilute hydrochloric acid the amount of hydrogen is determined by allowing 10 c. c. of it to act on an excess of zinc in an appropriate apparatus, the hydrogen being measured in a gas burette, accurate corrections being made for temperature, pressure, and aqueous pressure. In another known volume of the same acid the chlorine is determined by precipitation with silver nitrate.

By a careful selection of problems it is possible to give the student, within a reasonable time, practice in the careful use of the more common forms of chemical apparatus. In other words, the student can make a beginning at working as a chemist works instead of doing scarcely more than play with bottles and test tubes. Among other advantages of this method of instruction is the fact that the results which are obtained are usually a fairly good criterion by which to judge of the care with which the student has worked, and the student soon finds that careless work will not give good quantitative results. Also the student dwells long enough on a problem so that many details become thoroughly fixed—a result that is rarely obtained in qualitative work, except by means of many repetitions. I am aware that there are some practical difficulties in the way of carrying out the methods which I propose, especially in the matter of apparatus, but these difficulties are not nearly so great as they appear at first sight, and I am sure that they are not greater than those which have been overcome in many of our physical laboratories.—*Jour. Am. Chem. Soc.*

## THE SYNTHETIC POWERS OF MICRO-ORGANISMS.

By O. LOEW, University of Tokio, Japan.

AMONG all living organisms the micro-organisms, micrococci as well as bacteria, bacilli, and spirilli, are especially remarkable for their intensity of chemical activity. Oxidations and decompositions, reductions, and synthetical processes are effected on an extensive scale.

If we consider the destructive and the synthetical operations, we must arrive at the conclusion that the former are necessary for carrying on the latter. The former yield not only the forces necessary for the synthetical work, but also the suitable atomic groups. It is certainly a highly interesting question of physiological chemistry to study the relations of the two different directions and to elucidate which are the groups that serve for the synthetic work. We must first consider the chemical structure of the compounds that can serve as nutrients, we must investigate the causes that bring about the transformation of potential into actual energy, and we must recognize above all that the proteids of the living protoplasm are chemically distinct from those of the dead. We must acknowledge that when the labile character of the former changes by atomic migration into a stable one, the death of the cells has come.

Nutritive and poisonous qualities are relative conceptions. Poisons may become nutrients for bacteria when highly diluted, as phenol or acetic ether, and nutrients may become unfit for nutrition if the concentration reaches certain limits. Small chemical changes may convert a nutrient substance into a poison and again the poison into an indifferent substance.

As albuminous matter contains carbon, hydrogen, nitrogen, sulphur, and oxygen, we have to consider principally the question, which substances are suitable sources for the carbon, which for the nitrogen, which for the sulphur. Our experiments lead to the following conclusions:

1. As sources of carbon can be used in neutral or feebly alkaline solutions, alcohols, phenols, organic acids, ketones, aldehyds, carbohydrates, ethers and esters, many alkaloids.

2. As sources of nitrogen can serve: ammonium salts, nitriles, amido-acids, amines, ureas, guanidines, alkaloids, nitrates, and nitrites.

3. As sources of sulphur may serve: sulphates, sulphites, hyposulphites, sulpho-acids, mercaptans, sulphones.

It is remarked in a note that the nucleins, which contain phosphoric acid in their molecule, are here left out of consideration.

The following conclusions are drawn for most of the non-pathogenic microbia:

1. Hydroxylated acids are better than the corresponding non-hydroxylated ones, *e. g.*, lactic acid is better than propionic acid.

2. Polyvalent alcohols are more favorable for the development than the corresponding monovalent alcohols, *e. g.*, glycerin is better than propylic alcohol.

3. The nutritive quality of the fatty acids and monovalent alcohols decreases with the increase of the number of carbon atoms in their molecules. Thus acetic acid is better than butyric acid.

4. The entrance of aldehyd or keton groups increases the nutritive properties; glucose is better than mannite.

5 I have observed neither nutritious nor poisonous properties in picro-nitric acid, chloral hydrate, pinakon, ethylendiamine, glyoxal, amido-acetal. Acetoxime, diacetonamin, and maleinic acid are very poor nutrients. According to B. Meyer, mesaconic, citraconic, para methyl-succinic, dimethyl-succinic, and benzoyl-succinic acids are not capable of serving as food.

6. The poisonous properties are determined by the energy with which the unstable atoms of the living protoplasm are attacked.—*Central-Blatt f. Bacteriologie; Chemical News.*

## INCOMPATIBILITY.*

JAMES KENNEDY, Ph.G., M.D., Professor of Pharmacy, University of Texas.

BY the term incompatibility we mean that property possessed by certain bodies which renders them uncongenial to certain other bodies, and occasions a change in either one or both substances affecting either their physical or chemical constitution when brought into contact with each other. This definition applies to chemical and physical incompatibility.

We may study our subject under four different heads, as follows: 1, chemical; 2, physical; 3, pharmaceutical; 4, physiological.

*Chemical Incompatibility.*—Substances are said to be chemically incompatible when they react upon each other in such a way as to produce a new compound occasioning changes in the atomic structure of both. Acids and alkalies are incompatible, for the reason that there exists an affinity between them sufficiently strong to cause them to unite chemically. Their atoms enter into a close chemical union, and produce a new substance which possesses properties differing widely from either of its constituents.

If common bread soda (soda bicarbonate) is added to muriatic acid, we will find that the mixture will effervesce, owing to the escape of carbonic acid gas ($CO_2$). The resulting solution no longer possesses the characteristics of either the acid or the soda, and by evaporation of the solution we obtain the product of their union, which is common salt. The muriatic (hydrochloric) acid being composed of hydrogen and chlorine ($HCl$), the soda of sodium, and carbonic acid ($CO_2$) (having the composition of $Na_2CO_3$), double decomposition ensues, the sodium (Na) uniting with the chlorine (Cl) to form sodium chloride (NaCl), the hydrogen with a part of the oxygen to form water ($H_2O$), and the carbonic acid gas escapes ($CO_2$).

Another instance of chemical incompatibility, and one which will serve to illustrate the importance of a knowledge of the subject to both pharmacist and physician, is the changes occurring on the admixture of calomel (mercurous chloride) (HgCl) with muriatic acid. The acid nearly always containing free chlorine, the mercurous chloride takes up another atom of chlorine from the acid, and is converted into mercuric chloride, or corrosive sublimate, a compound differing greatly from calomel, both in its chemical constitution and physiological effect, the former being a relatively harmless cholagogue, while the latter is a powerful alterative in small doses, and a violent corrosive poison when taken in large amounts. . . .

Among the common errors that physicians make as pertains to compatibility in prescriptions are the following: Ammonium carbonate with sirup of squill in cough mixtures. These two substances are incompatible, for the reason that the sirup contains an acid (acetic) which acts chemically upon the ammonium salt, decomposing it, with the formation of ammonia acetate. Tannic acid is sometimes prescribed in combination with tincture chloride of iron, with the view of increasing the astringency of the mixture. The result is that an inky mixture is formed by the union of the tannic acid with the iron, which, in addition to producing an unsightly preparation, possesses less astringent power than was formerly possessed by either one of the constituents of the prescription. The same result will obtain if we combine preparations of iron with fluid extracts or tinctures containing tannin. Most vegetable substances contain tannin in greater or lesser amounts; therefore, if it is desired that iron should be combined with the active principle of the plant, the vegetable preparation should first be detannated; that is, have its tannin removed by the process of precipitation with the white of an egg. The tannin combines with this form of albumen and produces an insoluble compound which may be separated by filtration, leaving the liquid entirely free from its presence. The iron may then be added without producing any discoloration. There are a few drugs, such as gentian, calumba and capsicum, which do not contain any tannin, and may be combined with the salts or iron without producing any discoloration.

Iodide of potassium is frequently prescribed in solutions containing spirit of nitrous ether, and in the majority of instances a discoloration of the mixture results in a short time. This discoloration will not occur if the nitrous ether is perfectly fresh and pure. If, however, a slight decomposition has resulted, and owing to the facility with which decomposition occurs in this compound when exposed to light and air the preparation is seldom found pure on the apothecary's shelf, and may be safely set down as not being a good thing to prescribe in this form of combination. The discoloration which is produced is due to free iodine, resulting from the decomposition of the potassium iodide by acetic acid contained in the nitrous ether as a product of its decomposition under the influence of light and air.

Nitrous ether is often prescribed in combination with antipyrine, but these substances are incompatible in a high degree. The speaker was the first to call attention to the incompatibility of these substances, and in a paper which appeared in the *Pharmaceutical Record*, of New York, he published his researches on this subject. In a later and more exhaustive research conducted by him on antipyrine, the resulting compound was studied both chemically and physiologically (see proceedings of Texas State Pharmaceutical Association, 1889), and the influence of the changes in the substances due to the chemical decomposition, as affecting their medicinal value, was determined. The conclusions were to the effect that the new compound formed is not poisonous, and practically inert; that both the spirits of niter and antipyrine have their medicinal value lessened in proportion to the amount of each suffering decomposition. A mixture of antipyrine and nitrous ether will deposit green crystals if allowed to stand, provided there is not sufficient water present to keep the new substance in solution.

Acetate of lead and sulphate of zinc are frequently ordered in combination for use in the treatment of inflammatory affections of the genital mucous membranes, under the impression that the constringing power of these drugs is enhanced by so doing. This is a mistake. Double decomposition occurs when these two salts are dissolved together; sulphate of lead is precipitated as an inert substance, while the acetic acid is transferred to the zinc to form zinc acetate.

Strychnine is sometimes prescribed in combination with the bromides or iodides. This is a dangerous practice, for the reason that if the mixture has been allowed to stand for some time the bromide or iodide of strychnine will crystallize and be deposited in the bottom of the vial, and as the last dose of the medicine is taken the greater portion of this powerful drug contained may be swallowed, and perhaps with fatal results.

Illustrations of chemical incompatibility might be multiplied *ad infinitum*.

The following rules should be borne in mind:

Acids should never be prescribed with alkalies or their carbonates.

Alkaloids should never be prescribed in combination with alkaline carbonates.

Salts of the alkaline earths, *i. e.*, magnesium, calcium, barium and strontium, should not be prescribed with soluble carbonates, tartrates or oxalates, and in the case of the three latter elements they should never be combined with soluble sulphates, phosphates, arsenates, phosphoric or sulphuric acids.

The heavy metals, such as iron, manganese, lead, mercury, silver and zinc, should never be prescribed in conjunction with the alkalies, their carbonates or oxalates.

Silver should never be prescribed in combination with chlorides, bromides, iodides or hydrochloric acid or organic matter (substances of vegetable or animal origin).

The soluble salts of lead should never be combined with chlorides, hydrochloric, hydrobromic, hydriodic or sulphuric acid.

It is impossible to tabulate in a lecture of this kind the various incompatible combinations and mixtures, nor would such a tabulation be of any considerable use to either physician or pharmacist. An intimate knowledge of the chemical nature of the substances dealt with is the only infallible guide, the only beacon that can be relied upon to guide us safely past the treacherous shoals of this formidable gulf.

*Physical Incompatibility.*—By physical incompatibility we mean that property possessed by certain substances which causes them to change their physical properties when brought in contact with each other without affecting their chemical composition, a quality that in many instances may be overcome by the exercise of pharmaceutical skill. For instance, oils are physically incompatible with water (because of a lack of adhesion) and aqueous mixtures, but by the intervention of some viscid substance, *i. e.*, gum acacia, they may be rendered miscible in all proportions. Solutions of resinous drugs are physically incompatible with aqueous solutions, but by the intervention of some saccharine or mucilaginous material many resins may be rendered quite homogeneous.

*Pharmaceutical Incompatibility* is represented by that class of substance which, by virtue of possessing some property or properties that occasion an undesirable change when brought in contact with each other, and which cannot be overcome or prevented by the exercise of pharmaceutical skill. Of course, in this class of incompatibles we may have the occurrence of either physical or chemical change; for instance, when two or more salts are ordered in powders, and the water of crystallization of one is absorbed by the other, with the effect of liquefying the powder. Strongly alcoholic solutions are incompatible with sirups, for the reason that the sugar is very much less soluble in such media, and in the course of several hours a considerable proportion will be found deposited in the bottom of the bottle, making a very unsightly mixture.

A prescription may be said to be pharmaceutically incompatible when an amount of a given salt which is in excess of its solubility is ordered dissolved in the liquid.

Physiological incompatibility is the property pos-

* Lecture delivered before the medical and pharmaceutical students of the University of Texas, and communicated by the author.—*American Druggist.*

sessed by one medical substance of neutralizing the therapeutic effect of some other remedy. Medicines possessing this property should never be ordered in combination.

In conclusion, gentlemen, I will state that I have not told you all that you should know concerning this very important subject, but I hope the suggestions which I have given may be fixed upon your memory by the illustrations you have seen this morning, and will incite you to a more exhaustive study of the subject.

When the physician has learned to write compatible prescriptions, and the pharmacist has so mastered his calling that he can dispense the same in a reliable, palatable and sightly form, then will the occasion for mutual criticism have disappeared and given place to mutual respect.

[Continued from Supplement, No. 956, page 15280.]

## STUDY OF SNOW CRYSTALS.

By Prof. Dr. G. Hellmann.

(Translated for the Scientific American.)

*Structure of Snow Crystals.*—I pass now to observations on the external and internal structure of snow crystals, which is the most important division of this attempt at their study. Here the photomicrographs have performed an excellent service, as by this process the crystals are firmly held, and accessible to every one. In direct microscopical observation, only a single crystal can be scrutinized, and that only in fragments, as the quickly changing contour and structure of the crystals make a lengthy observation of them very difficult, and often impossible. It is really surprising that such eminent observers as Scoresby and Glaisher discovered nothing in regard to the internal structure of these crystals, or at least published nothing about them. Possibly in their attempt to draw as many as possible they found no time to examine closely the conditions of their formation.

In examining the six-rayed stars and the forms derived from them we find that they have a principal ray and secondary rays, which are not always opposite each other. The strengthening or re-enforcing of the principal rays near their starting point, for a short distance of from 0·2 to 0·3 mm., is sometimes so strongly marked that it appears as if a smaller star were laid concentrically upon the larger one. This may be seen in Fig. 1*a*.

The most remarkable thing in the structure of the principal and secondary rays is this: they contain capillary, hollow spaces. Formerly these hollow spaces were only known to exist in the crystals having the form of six-sided prisms. In 1681 Rossetti observed this, and later Wilcke. There can be no doubt now that all forms of snow crystals contain these capillary hollow spaces. I observed it for the first time in a plate-shaped crystal, where they are usually larger and more easily observed, but they may also be distinctly seen in the rays of the star-shaped crystals. Here the hollow spaces are in the form of capillary tubes, which run out to a point at the ends, and lie symmetrically on both sides of the ribs. The inner elongation of these capillaries running parallel to each other usually amounts to from two to five hundredth part of a millimeter, and the tubes at their thickest place are about the same width. The outrunning points of these capillaries are turned toward the middle point of the star. Sometimes there lies before these ends, precisely in the prolongation of both capillaries, two or four diminutive hollow spaces, in form of a blister, which may be considered as the starting point of the formation of the capillary tubes.

It seems to me a fortunate circumstance that I am not alone in ascertaining the existence of these capillary hollow spaces. Herr G. Nordenskiold also points them out, especially distinct in tabular crystals. A good example is shown in the large star with tabular center at the left below in Fig. 6. In the inner star two symmetrical systems of hollow spaces may be observed by means of a magnifying glass; one of long drawn out blisters on the inner side of the edges, their long axes running parallel to the edges, looking not unlike six pairs of ants' eggs; then in front of these, in the direction of the center, and standing perpendicular to them, running almost in a radial line, a similar pair of smaller hollow spaces may be observed. It might be objected by some that these are simply points of melting, but their appearance is against this. Melting points look quite differently. Besides, the symmetrical arrangement of these capillary hollow spaces could not depend upon a mere accident.

Is it not a most interesting fact that these capillary, hollow spaces are shown in the beautiful drawings made by Rossetti in Turin, more than two hundred years ago? In the *facsimile* of his drawings, Figs. 5 and 10 show these spaces distinctly. This speaks well for Rossetti's talent for observation. These characteristics were well known to him, in the formation of that class of snow crystals called by him "rosettes;" on account of their great brilliancy he called them "gioie" (jewels), and made various remarks upon them without finding out the correct explanation. Of the later drawings, only those of Waters show hollow spaces—they are not seen in the drawings of Scoresby and Glaisher.

These capillary hollow spaces appear to me to be one of the most important characteristics of snow crystals, distinguishing them from other ice formations. I have never seen these hollow spaces in the frost figures upon the window panes, although cylindrical forms are seen, and fern-like ice formations, similar to a feathered snow star. As is well known, ice arising from frozen water exhibits a great number of air bubbles.

Another characteristic of tabular crystals, which deserves special mention, is the frequent appearance of narrow facets on their edges. I have only twice observed crystals with these facets, but the dark border on the tabular plates in Figs. 6, 8, 9 and 11 proves that they appear frequently. They are well developed in the tabular star, Fig. 11, which furnishes a beautiful model for a reel, also the two plates in Fig. 9 have beautiful facets. Unfortunately it has never been possible to measure the angle which the facets make with each other. Kamtz, who observed these facets, gives a drawing in detail of the vertical incisions of such a faceted snow crystal, from which Galle and Bravais have derived conclusions in regard to the theory of the rings about the sun and moon. Hollow spaces appear in all the prismatic forms. Their form and position cannot be clearly perceived in our photo-engravings. The original pictures, also observation with the microscope, show that the hollow spaces lie in the direction of the principal axis. Until recently it has been supposed that these hollow spaces contained only air, but Herr G. Nordenskiold, on the 8th of February, 1893, in Stockholm, made the interesting observation that ice prisms falling on that day contained both air and water, the temperature being —8°.

Beautiful examples of twin crystals may be seen in Fig. 4. The crystals, looking somewhat like a cauliflower, seen in Figs. 10 and 12, may be new. They probably originated by a regular snow crystal, in falling to the ground, passing into a stratum of air, which contained uncongealed water drops; the drops, by coming into contact with the snow crystals, were stiffened into amorphous ice.

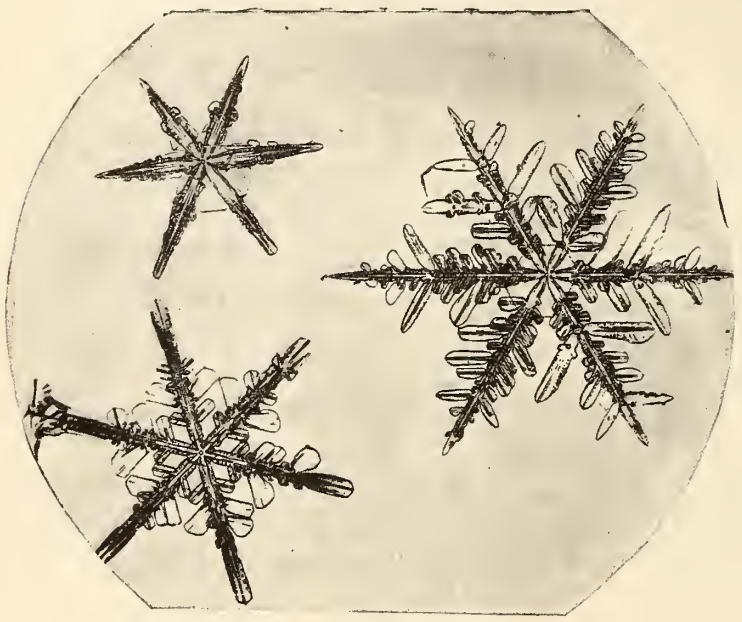


Fig. 5.

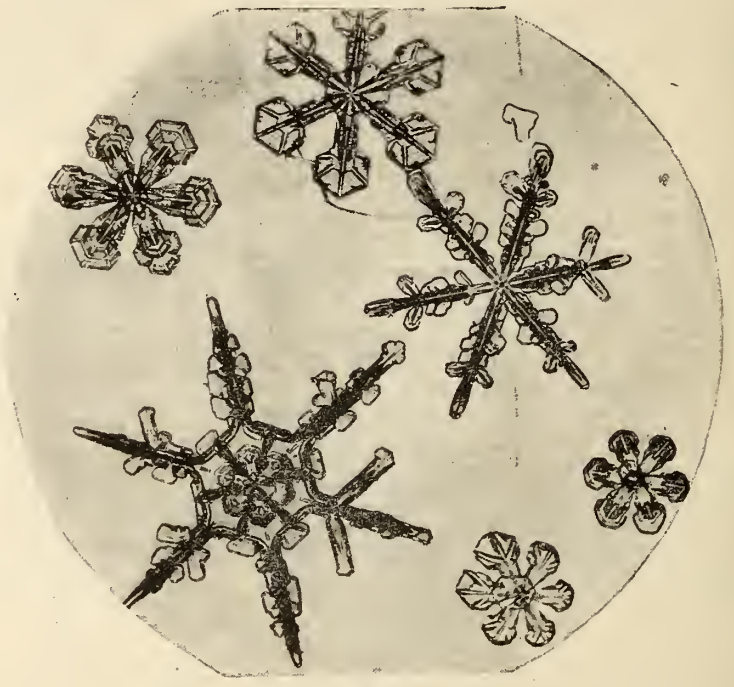


Fig. 6

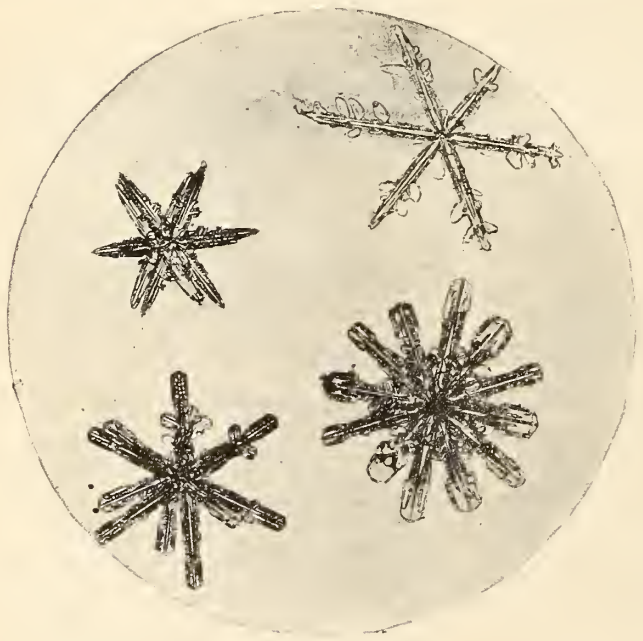


Fig. 7.

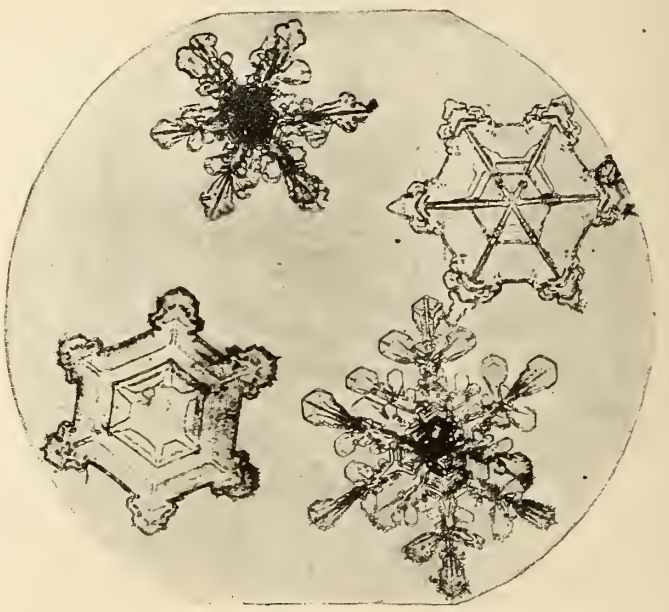


Fig. 8.

## PHOTOMICROGRAPHS OF SNOW CRYSTALS.

*Dimensions of Snow Crystals—Dependence of Size and Form upon the Tem perature.*

We are able now, by means of the photomicrographs, to take all the time necessary for the measurement of the snow crystals. While in direct observation under

the microscope such measurements had to be ma le very quickly.

In drawing snow crystals in the winter of 1882–83, I observed that the pure star-shaped forms were, on an average, larger than the tabular crystals. In making a number of measurements, I found the star forms had an average diameter of 2·8 mm., the tabular forms 1·9 mm. Comparing these forms in the photomicrographs, I find a complete confirmation of my observations for the last eleven years. The largest snow crystal shown in the photographs is the rudimentary star in Fig. 2, which has a diameter of 7·2 mm. The smallest tabular crystal is shown in Fig. 9; the diameter is only 0·3 mm. Scoresby discovered that the stars were larger than the tabular forms. Rohrer also remarked the difference.

If it is assumed that for the formation of snow crystals of both forms, at the same temperature, the same

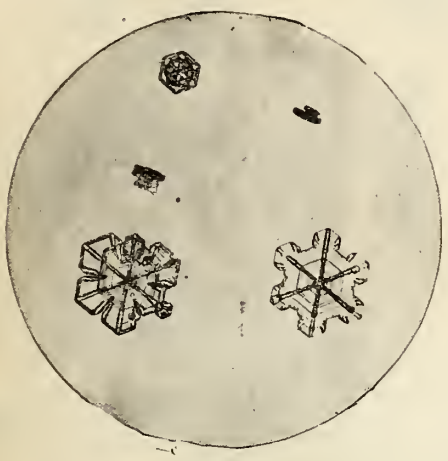


FIG. 9.

amount of aqueous vapor is used, it is easily understood that the compact tabular form must turn out smaller than the radiated star. From a regular hexagon of 1 mm. diameter one could make a star of nearly 2·2 mm. diameter. Of the dimensions of six-sided prisms we cannot make as accurate a statement, because the number of observations is much less. In the same snowfall the proportion of the length to the thickness usually remains about the same.

Another question which requires close investigation is the dependence of the size of the snow crystals upon the temperature.

Scoresby knew that, "as the cold increased, the size of the crystals diminished." Fritsch and Rohrer also observed this. I noticed the same thing in the winter of 1882–83, when I made my measurements of crystals. At —10° C. the crystals were nearly three times smaller than at —2° C. The photomicrographs, which permit closer measurements, give analogous results. The explanation of this is very simple. With diminishing temperature, the capacity of the air for containing aqueous vapor is diminished; under equal conditions, the size of the snow crystals diminishes.

This explains the remarkable smallness of the snow crystals in the polar regions—"diamond dust." Snowfalls at a temperature of from —20° to —40° C. are not uncommon in the Arctic regions. At —30° C., one cubic meter of saturated air contains only 0·5 gramme of aqueous vapor; at —6° C., 3·2 grammes; at —8° C., 2·7 grammes; and at —12° C., 2·0 grammes.

The temperature affects not only the size of the crystals, but also their form. Early writers asserted that at a certain temperature certain forms of snow crystals would appear very frequently or rarely. Opinions are quite contradictory in regard to this statement. In later times Fritsch and Tissandier deny such connection, stating that all the forms they have observed make their appearance at high as well as low temperature. This is correct; but if an investigation is made as to which form of crystal predominates at different degrees of temperature, it will be found that there is a certain conformity to law. The photomicrographs gives us the following per cent.: In thirty-one snowfalls at a temperature of —6° to —7·5° C. there was found to be 52 per cent. of star-shaped crystals, 22 per cent. of stars with tabular spreading at the point of the rays, and 26 per cent. of tabular crystals.

In twenty-one snowfalls at a temperature of —9° to —12·5° C. there was 24 per cent. of stars, 19 per cent. of stars with tabular ends of the rays, and 57 per cent. of tabular crystals. This distinctly shows that with diminishing temperature the number of tabular crystals increases and the number of star-shaped crystals diminishes. Dogiel, in his experiments of producing the forms of snow crystals artificially, arrived at the same results. He says: "In my experiments, I obtained a predominance of tabular crystals when the heated alcoholic solution in a test tube containing 15 to 30 per cent. of iodoform was placed for ten minutes in water from 14° to 15° C.

Star-shaped crystals and some complicated groups of crystals appeared when the test tube was placed in water from 26° to 27° C.

*New Classification of Snow Crystals.*—I have been led by my own investigations and the observations made and published by others to make a new classification of snow crystals. Scoresby, whose system of classification has been generally adopted, assumed five foundation forms of snow crystals. It seems to me more appropriate to give more value in the classification of the crystals to the fundamental rules of crystallography.

The hexagonal system to which snow crystals belong possesses three equal axes, which intersect each other in the same plane at an angle of 60°; the fourth axis is not equal to these three, and stands perpendicular to their point of intersection. This last is called the principal axis; the three others are called secondary or transverse axes.

I classify snow crystals under two principal heads with several subdivisions.

I. Tabular snow crystals; that is to say, those with a predominating flat development in the plane of the secondary axis, N. With these the principal axis, H, is very short: $\frac{H}{N}$ usually smaller than 0·1.

1. Radiated stars.
2. Plates.
3. Combination of both.

II. Columnate crystals; that is to say, those with a tolerably regular development of the four axes.

1. Prisms.
2. Pyramids.
3. Combination of tabular and columnar.

I make use, also, as a principle of classification of the proportion of the length of the principal axis, H, to that of the secondary axis, N, or the greatness of the quotient $\frac{H}{N}$. With the first type of crystals the numerical value is usually smaller than 0·1; with the second it varies between 1 and 5.

By far the greater number of crystals belong to the first type. Indeed, it may be said that only crystals of this kind are generally known. From my own observations I find that the tabular and star-shaped crystals form nearly 80 per cent. of all the forms observed. In the polar regions a like proportion is found, for, of the ninety-six figures given by Scoresby, we find only seven which belong to the second class. Rohrer, who also took the temperature into consideration, found a greater predominance of the first principal division, namely, 90 per cent.

It will be very near the truth to assert that three-fourths of all snow crystals belong to the first class.

In regard to the regular six-sided prisms, it may be said that they are seldom observed. The height of these prisms is seldom less than the diameter of the base. In those I have observed the proportion of the length to the thickness varied between 1·5 and 4 5. We know little of the frequency of the appearance of the six-sided prisms; but, as is known, the existence of these prisms in the atmosphere is advanced as an explanation of the rings abont the sun and moon. In this case they must appear much more frequently than they are observed upon the earth. Pyramids appear to be the rarest of all forms of snow crystals. I have never seen them. Scoresby observed them once. Undoubtedly there are a large number of snow figures which are not contained in our system of classification, but they represent no foundation forms, but are only a conglomerate of such forms. They have, at the most, only an appearance of crystallization, but are not crystals.

*Origin of Snow Crystals.*—Of the origin of snow crystals in general, there exists scarcely a doubt. Many facts prove that snow crystals are formed immediately from the aqueous vapor in the atmosphere, without passing into a fluid condition. There follows

FIG. 10.

a direct transition from the gaseous state to the solid state—a sublimate.

Muncke, in the year 1816, showed some beautiful experiments of this process of sublimation. He placed a small quantity of ice at one side of a glass globe, put it on the sill of an open window, in a room where the temperature was somewhat warmer than the outside air, so that the side of the globe which contained the ice was toward the room. When the warm air of the room rushed through the globe to the outside, invisible small particles of ice quickly rose as vapor, from which originated beautiful and regular snow crystals on the opposite side of the globe.

Since then similar occurrences in nature have been observed, especially in balloons and in the polar regions. Tissandier treats of this subject in his book "L'Ocean Aerien." Other accounts tell us of travelers in the polar regions who, with a clear, blue sky above, have seen snow crystals form in the lowest stratum of the atmosphere. At great heights, as well as in the Arctic regions, the moisture from the breath may be seen changing into microscopic ice crystals. We have accounts of snow forming in warm rooms by the sudden entrance of cold air. It is said that a snowfall occurred in an overcrowded saloon, at St. Petersburg, in which, some ladies fainting from the heat, a gentleman quickly broke in a window, letting in suddenly a rush of cold air.

The opinion advanced in some of the old text books, and also in some of the later ones, that the atmospheric downfall appears as snow when the water condensing from the aqueous vapor immediately freezes, must be held as untenable. If downfalling drops of water which have a higher temperature than zero suddenly freeze, ice crystals never appear, but amorphous ice globes, which fall as sleet.

We may assert with great probability that the starting point or the germ of snow figures is to be sought in the little microscopical snow points which are met with abundantly in the higher stratum of air and in the polar regions. The smallest snow figures are found in the polar regions, because their place of origin lies

FIG. 11.

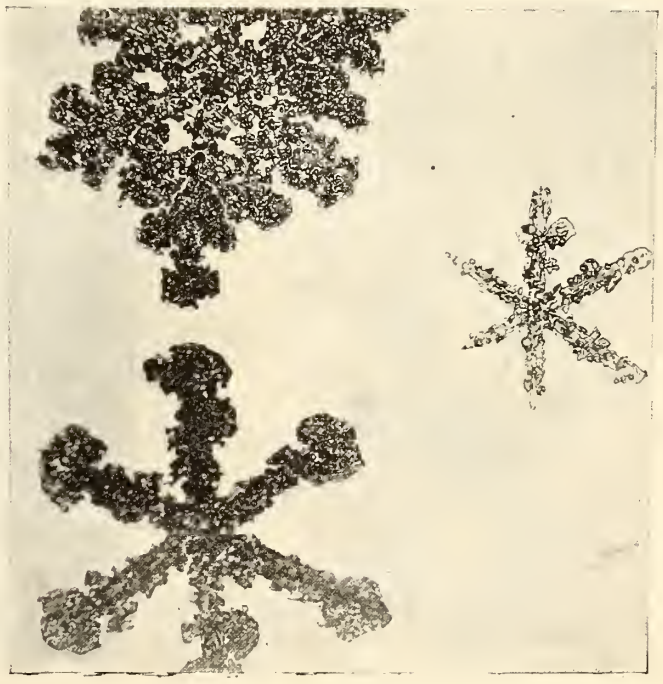


FIG. 12.

## PHOTOMICROGRAPHS OF SNOW CRYSTALS.

so near the ground. They have no opportunity in their downfall for further development.

The origin of snow crystals is, without doubt, similar to the separation of crystals in a warmed salt solution. At first small crystals form upon the surface, which as specifically heavy bodies fall slowly to the bottom, and during their fall visibly increase, until they lie upon the bottom of the vessel in large flakes.

In the year 1790, Monge compared snow flakes to flakes of salammoniac, originating in this manner. The capillary hollow spaces, or air blisters, which appear in all snow crystals, originate with them, and may be explained in the same way as the air bubbles which are found frequently in ice and hail stones.

The most difficult question of all remains, the cause of the various forms of hexagonal crystals, which frequently change in the same snowfall. Instead of advancing a new hypothesis, it is better to acknowledge that we no know nothing positively in regard to this. In our knowledge of the form and structure of the snow we have made great advance since the time of Kepler, but, after nearly four hundred years, we cannot give a satisfactory answer to his question "Cur autem sexangula?"

We do not know the special conditions which determine the formation of one or the other form of snow crystals. We have seen that a low temperature favors the formation of tabular crystals, a higher temperature the star-shaped crystals; these groups show such multifarious forms that it is necessary to seek for other causes which influence the formation of snow figures. There is offered here a broad field for new investigation and study.

## THE WILD CLEMATISES.

By S. Mottet.

Among clematises, one of the finest races of our hardy climbing plants, two classes may be made for garden purposes: one, including the large-flowering garden varieties, such as those that have been raised from crosses or selections of C. patens (De C.), C. lanuginosa (Lindl.), and C. hakonensis (Franch. et Savat); the other including all the introduced species which have kept their characters under cultivation or have given rise to but a few varieties. In the eyes of florists, the former are by far the better and much more esteemed.

CLEMATIS CIRRHOSA.

Hundreds of varieties are now grown, but they are rather delicate.

Those of the second class, although having smaller flowers, have a charm of their own, which they owe to their hardy, vigorous, and free-flowering character. These in the eyes of the true lover of plants are the finer, because they have kept their own natural grace.

The hardy-climbing clematises have many uses in gardens, such as covering arbors, trellises, walls, etc., but they look perhaps best when climbing upon old trees or hanging in elegant festoons from the tops of ruins; they may also be planted along walks, where

CLEMATIS VIORNA.

three poles tied together at the top provide a convenient support for them; in rockeries and the wild garden they may be let to ramble at will over the stones or on the soil, and for garnishing the front of buildings, balconies, etc., they are almost unrivaled. The wild clematises only will be dealt with in this paper.

Clematis orientalis (Linn.),* sometimes known in gardens under the name of C. graveolens, is perhaps the best of the half-dozen yellow species introduced. It is quite hardy, and flowers most profusely from August to October. It was introduced as long ago as 1771, from the Himalayan regions. The flowers, from 1½ inches to 2 inches across, are bright yellow, hardly scented, borne singly on peduncles from 3 inches to 4 inches long, and forming by their union clusters in the axils, or rarely on the top of the shoots. The sepals are four in number, or very rarely five or six, oval lanceolate, mucronate, spreading, almost flat, downy, and recurved on their edges.

The fruits or carpels are olive green, with some scattered silky hairs, and their styles are long, feathered, dirty white, and quite reflexed; they form conspicuous and numerous downy heads, looking much like those of our Virgin's Bower or Traveler's Joy. The leaves are opposite, long-stalked, bearing three to seven leaflets, green on both sides, quite glabrous, and with their edges more or less frequently and deeply cut; the secondary stalks often twist themselves against

CLEMATIS GRAVEOLENS.

neighboring objects, acting the part of tendrils to assist the plant in its way up the trees.

C. montana (Buchan)* comes next in merit to the above; its flowers are pure white, 1½ inches to 2 inches or even 3 inches in the variety grandiflora, and look much like those of Anemone sylvestris; their stalks, 6 inches long, without bracts and one-flowered, make sessile clusters in the axils. The leaves, with rather long stalks, bear, as a rule, but three closely-set and shortly petiolate leaflets, which are toothed at the base and quite glabrous. This blooms in spring and beginning of summer, and is quite as vigorous and hardy as the former. It was introduced about 1831, from temperate Himalaya, Sikkim, etc., where it grows at 6 000 feet to 10,000 feet.

C. Viticella (Linn.)† is another important species of very variable character, and differs entirely from the former. The flowers are blue, violet, purple, pink, or sometimes pale white, from 1 inch to 2 inches broad, borne singly in the axils, or sometimes three to seven together on the top of the shoots, with very long slender stalks. The stems, which are at first slender and four-angled, never become large. This is one of the oldest inhabitants of our gardens, growing wild in the Mediterranean region, from Italy to Central Asia; hardy, but liable to be cut down by severe frost. There are a few varieties, notably a double one, which is

CLEMATIS DAVIDIANA.

purplish violet colored, hardier and taller climbing than the type.

C. flammula (Linn.) is a near ally of our wild indigenous species Old Man's Beard (C. Vitalba), but with larger flowers, of a creamy white shade, very sweetly scented, not woolly outside, save on the edge. The leaves are also quite different, being bipinnate, with small, thickish, entire leaflets and much twisted stalks, while the leaves of C. Vitalba are simply pinnate, with five large, thin, and coarsely-toothed leaflets. Both plants have small, but innumerable flowers, which expand from July to September, and a woody stem. C. flammula grows wild in the Mediterranean region up to the center of Europe, while C. Vitalba extends to the north.

Among other wild climbing and hardy species introduced into gardens, but not so generally grown as the above, we may mention:

C. aromatica (Lenne and C. Koch), with deep, blue-violet flowers, smelling like heliotrope, and whose stems attain about 6 feet. Its native country is unknown.

C. campaniflora (Brot.), from Portugal, with purplish white half-opened flowers, and leaves bearing about twenty-four leaflets.

C. cirrhosa (Linn.), from South Europe, with creamy

CLEMATIS ÆTHUSIFOLIA.

white, involucrated flowers and persistent leaves. C. balearica (Rich.) is now referred to this species.

C. crispa (Linn.), with pale lilac or purple bell-shaped and nodding flowers.

C. eriostemon (De C.) (C. Hendersoni, Hort.), with blue-violet, widely-opened and solitary flowers. It is supposed to be of North American origin.

C. indivisa (Willd.), from New Zealand, with creamy-white paniculated flowers.

C. paniculata (Thunb.), from Japan, a small flammula-like flowered species.

C. Pitcheri (Torr. and Gray), from North America, with dull purple tubular, strangulated, solitary, and nodding flowers.

C. reticulata (Walt.) rather newly introduced from the United States, with campanulate flowers, pale yellow inside and reddish outside.

C. texensis (Buckl.) (C. coccinea, Engelm.), with small, very thick, long-stalked, and almost top-shaped flowers, bright crimson outside and yellow inside. It requires some protection in winter.

C. Viorna (Linn.), the leather flower from North America, is closely related to the preceding, from which it differs chiefly by its flowers not being conical and reflexed at the summit of the segments. It is also hardier, and has been introduced since 1730.

C. virginiana (Linn.), from the same country, has small, white, dioecious paniced flowers, and its shoots will climb up to 16 feet or 18 feet.

The non-climbing bushy clematises have also their value in gardens to decorate the herbaceous border, the rock garden or to form isolated clumps on the lawn The best are:

C. æthusifolia (Turcz.), from Mongolia, with long, tubular, hanging, white flowers. It grows from 4 feet to 6 feet high.

C. Davidiana (De C.), (C. mongolica, Hort.), from China, produces axillary and thick clusters of porcelain-blue flowers of cylindrical shape, expanding as late as September. Its leaves are trifoliate and of a grayish tint.

C. integrifolia (Linn.), from Southern Europe, is distinguished by its entire, large, sessile and opposite leaves. It produces fine nodding flowers, deep blue inside and velvety grayish outside, on solitary and axillary peduncles, 6 inches to 8 inches long. It blooms in August.

C. ochroleuca (Ait.), from the United States, is similar in habit and shape of leaves, but its flowers are creamy white inside and yellow outside.

C. recta (Linn.), from South Europe, has very numerous small, white, and scented flowers, looking like those of C. flammula. The stems are herbaceous, more or less erect and do not exceed 3 feet.

C. stans (Sieb. and Zucc.), introduced in 1880 from Japan, has pale blue flowers, hanging, subverticillate and forming terminal panicles.

C. tubulosa (Turcz.), from China, has long, cylindrical light blue flowers, set in whorls on long, upright spikes. The leaves are opposite, long-stalked and bear three large oval leaflets. The stems grow upright to about a height of 2 feet. The C. Hookeri (De C.), referred by some authors to this species, differs chiefly by its lilac flowers.

This species, as well as C. Davidiana and a few others, have a quite special aspect entirely different from the host of clematises, and which they owe to their narrow tubular flowers, looking like florets of hyacinth, besides their herbaceous and bushy habit.

All these non-climbing clematises do not become

* Clematis orientalis (Linn.)—Lavallee, *Aboret. Segrez.*, t. 29; *Clematites*, t. 21; C. graveolens (Lindl.), *Journ. of Hort. Soc.*, i., 307, cum ic.; *Bot. Mag.*, 4,495; *Fl. des Serres*, vi., t. 548; *Jard. Fleur.*, t. 128. C. flava, De C.

* Clematis montana (Buchan).—*Bot. Reg.*, 1840, t. 53; Sweet's *Brit. Fl. Gard.*, ii., t. 253; *Rev Hort.*, 1856, t. 43; var. grandiflora, *Hort.*; *Bot. Mag.*, 4,061; C. anemoniflora, D. Don.; C. napalensis, De C.

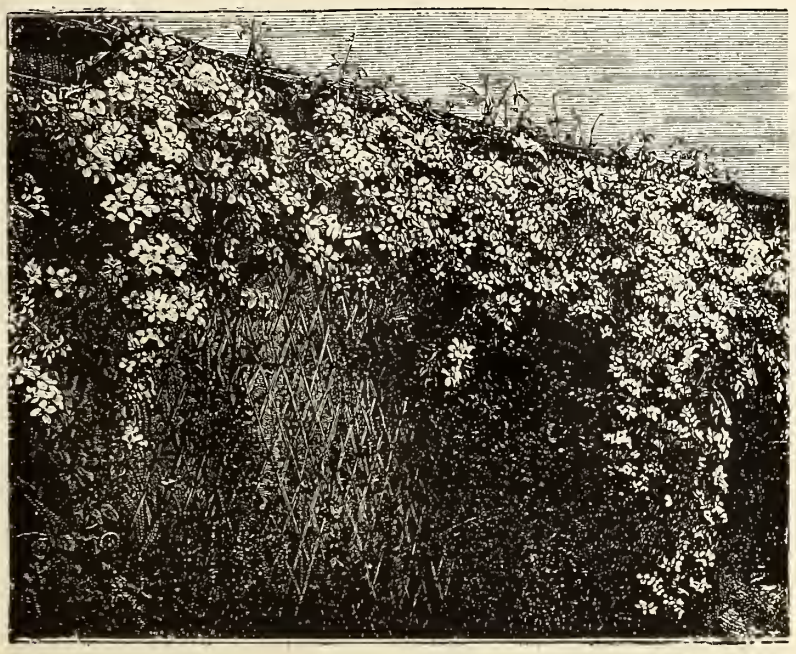
† Clematis Viticella (Linn.), *Bot. Mag.*, t. 565; Reich. *Fl. Germ.*, iv., t. 65; Sibth. *Fl. Græca*, t. 516; Lavallee, *Clematites*, t. 7; Viticella deltoidea, Mœnch.

woody at the base and die, or are cut down to the soil by the frost. They may be treated just like herbaceous perennials, which they are in fact, and are easily propagated, when seeds fail, by dividing the roots in spring.

The species described above, and more especially the first-named, are hardy and need but little or no care when once established. Pruning is not necessary beyond the cutting in to due limits or taking away the dead parts. Most of those here noticed bloom on the young wood and may be shortened at will; but C. montana blooms on the wood of the preceding year, and this must of course be preserved for the sake of the flowers.

As a rule, clematises like a deep, sandy loam, rich and well drained; some refuse to grow where there is chalk, others do not mind it. Watering in dry weather, and especially during the season of growth, materially assists them, and some liquid manure may be given with benefit. When seeds are produced this is the easiest mode of propagation, but as they do not retain their germinating power for a long time, they are best sown when ripe, outside or under a cold frame. They may also be mixed with fresh sand in a pot or box and sown the following spring.

Layering is also an easy and sure process, useful for amateurs, as the layers root generally the first year. Young cuttings of most varieties may be struck in heat, and grafting in heat, under bell glasses, on roots of C.



CLEMATIS MONTANA.

Vitalba, C. Viticella and others, is the way by which nurserymen propagate garden varieties or any delicate or scarce species.

## A GREAT BARN.

FOR six months there have been actively engaged at Ellerslie, near Rhinebeck, Dutchess County, N. Y., Mr. L. P. Morton's stock farm, all kinds of workmen employed, rebuilding the barn destroyed by fire on August 2, 1893, and it may be said it is the only work that has been going on in the town for the past six months, and the benefit derived has been great to this community. While Mr. Morton has been in Europe he has been helping his fellow townsmen very much, contributing to their support by giving them work. The general plan from which the barn was rebuilt this year is the same as drawn by Mr. Dudley Newton, architect, of Newport, under whose supervision the builders, Ackert & Brown, worked last year. There have been some very decided improvements carried out this year that were not in the barn last year, and, upon the whole, the structure is a much better one.

It was rebuilt by Ackert & Brown, of our town. Mr. Morton has added to the barn some extras which were not considered in last year, and greatly added to its cost, and upon the whole they have been worth the time and expense. To appreciate the amount of labor and material in the barn, it needs to be seen, and then it begins to dawn upon the mind of the beholder what it is to build a barn and have all first-class appointments.

The barn is 297 ft. long, 65 ft. wide and 50 ft. in height, with an L 89 ft. by 52 ft. The barn includes, besides, three 500 ton silos, each 47 ft. deep, a tool and engine room, lavatory and bath room, grain bins, and ample hallways, no less than 120 common stalls, and 46 box stalls on the main floor, and an equal number are placed in the basement, which is light and airy, its floor bottom being level on one side with the ground, while on the other side its windows are protected by an area wall, having a heavy coping on top guarded by an iron pipe fence 4 ft. 6 in. high.

The bays above the stalls accommodate 400 tons of hay, without covering over the corridor, and the grain bins will hold 20 car loads of grain. The main door on the south, looking up through the center of the building, is large enough to admit an engine and train of cars, and it would have more than ample room inside, the passage being 16 ft. wide and 39 ft. high in the clear. The cows stand in two long rows in the basement; on the main floor they are placed head to head, with a wide feeding alley between them, and back of them are the rows of large, roomy box stalls for calves, bulls, and lying-in cows. In laying out the plans, no point of hygiene, comfort or convenience seems to have been overlooked; the basement is made light and airy, windows run to the bottom and give an abundance of light; the air is kept pure by means of box ventilators running from the basement and out of the roof of the lantern. These ventilators are also used as a hay chute, to convey the hay from the loft to the main and basement floors.

The ventilation for the main floor is operated by opening the lantern sash, which has 78 in number, and are attached to a shaft that runs the whole length of the lantern, and a perpendicular shaft running down to the main floor operates six sashes at once.

On the main floor the windows are fitted up with blinds and hung with Worth's patent awning blind hinges, and they can be used as a common blind, and also be adjusted so as to form an awning. The gutter on the outside of the building is of galvanized iron, and patented by Mr. Dudley Newton, of Newport, and was only used by privilege on this barn, as Mr. Newton, the architect, last year used it, it being his own, and the builders this year were granted the privilege of using the same style of gutter. There are 15 conductors, 8 of which lead the water to the bottom of the area on the east side of the barn, the bottom of the area forming a gutter to carry the same around the south end of barn into a drain. In this way the water is carried away from the barn. On the west side the conductors connect in a system of tile drain which carries the water to a main drain.

It required 250,000 ft. of yellow pine timber and 250,000 ft. of spruce to construct the building. It also required 310,000 shingles to cover the roof and sides from the brick wall. These shingles are cedar. After using all the brick that were good that passed through the fire, there were purchased 330,000 brick. Carpenter work was begun August 10, and the frame was framed by the system of box framing, not usually done in a barn; the timber was all planed yellow pine; all work was done in the most workmanlike manner, and must cast favorable reflection upon the builders. There have been actively engaged in the rebuilding of the barn about 100 men steadily employed, divided up into about 70 carpenters, 10 masons, and 20 laborers. These men have been under the immediate supervision of Ackert & Brown, the builders, and we should judge it must speak well for the firm to have built the barn and then have established themselves so well in Mr. Morton's confidence that he could go to Europe and leave the barn in their hands to rebuild, so complete in every detail, with all the labor employed; there has been given by the builders work to men who have applied, living in this community, and it has been a great help, not only to the builders, but to the men in their employ, who appreciate their efforts and Mr. Morton's generosity. There was paid to workmen about $20,000. and, in these times, when men are curtailing their expenses, this money has done a great amount of good.

The main floor of the barn is made of 2 by 9 spruce tongued and grooved, plain side laid down, and then there was applied a coat of tar, then 3-ply tarred paper was laid on it which was covered with tar, on this for a finish floor 1¼ by 5 in. tongued and grooved spruce was laid, making a floor 3¼ in. thick and perfectly water tight. In the rear of the common stalls on the main floor is a gutter, 19 in. wide and 8 in. deep at the deepest part, the bottom slanting to 4 different traps in it to carry to the main drain which conveys everything to the cesspool, when it will be pumped in a sprinkler and drawn out and sprinkled on the land.

The cows in the common stalls are secured by the Watters patent fire escape and labor saving fasteners by which animals, whether two or fifty, occupying stalls in a row, can be set loose instantaneously by pulling a lever attached at the end of each row 1½ in. A child can do it; the chain drops to the floor and releases the cow: a single animal can be released with greater ease than when fastened in the usual way. The cows have constantly before them fresh water in iron buckets, supplied with the Buckley device, which has been provided with wooden covers, to prevent hay and feed from getting in. The furniture and iron work in the barn is perhaps the best that could be had for its several uses. The barn door hangers are the Coburn patent rollers, and it has been decided that they are the best roller in the market. The fastenings for doors are mostly of the Worthilip box stall door latch, with brass cup handles inside and out. The fastenings for stall doors are Conray's extra heavy refrigerator door fasteners, which are used on the doors of the ventilator chutes. All fastenings and hinges are galvanized, to prevent rusting. Behind the common stalls is Stewart Bros. self-cleaning stable grating, which covers over the gutter and makes the cows stand on a level. These gratings passed through the fire and were taken apart and straightened, speaking well for the material of which they were made; this being the only iron which passed through the fire and was used again in the barn. The box stalls have T gutters leading to the main gutters in the barn. The overhead trolley track has four lines on each floor. Carriers are provided to carry cars with feed to the cattle and also to carry manure to manure shed, where it is dumped in wagons and then carried out and spread upon the land. The track and carrier are so arranged that each carrier can be run upon every track by the use of turntables and switches; track guaranteed to carry 5,000 lb., and to be easily moved by one man. In the ell part there is a hay carrier to unload hay or grain, with the use of sling, and deposited at any spot in the mow. It is calculated for three slings to the load, a great improvement on the patent hay fork. The system of drainage is the best that can be used, especially for cleanliness. There is one main drain in the east side of the barn, in the basement, running the whole length of the barn, consisting of an 8 in. steel pipe, put together in sections, and 4 cross drain pipes from the gutters above, carrying everything from the gutter to cross gutter at the north end of stable which leads to cesspool. The main gutter in basement is made of concrete, the bottom of which slopes to the main cross gutter which empties into the cesspool. The basement bottom is made of concrete 6 in. thick, with brick piers to accommodate chestnut sleepers, which carries a 2 in. floor of spruce, where stalls are put in and fitted up same as on the main floor.

The water pipes in the basement are all covered, to prevent freezing. In the L part of basement there is a root cellar, which can be filled from the main floor through a trap door. Three compartments in this cellar, with a shelf partition in each, made of slats 1 in. apart, 1¼ by 5 in. spruce. The barn is fitted up and completely lighted with electric light, put in by Mr. B. W. Philbrick, electrician and engineer, who is constantly employed on the place doing all plumbing, gas and steam fitting. There are 30 lights in the barn run from storage batteries. The electric heat alarm system is extended throughout the barn. A thermostat being placed 15 ft. apart on every floor, on the roof and in each ventilator, closet and room. At no point can heat rise above 140° without the alarm being given in the farm house by the ringing of a large gong over the main south door of the barn, on the outside, and so long as the heat continues the bells will ring and continue the alarm. There is over the main door to the superintendent's office, outside, an indicator that records the place where the heat or fire is. There are in the barn 300 thermostats and 6 miles of wire, it being the largest stock barn ever fitted up with the heat alarm system. Connected with this alarm in the superintendent's office is an ingenious clock, by which the superintendent can test daily and see that the whole system is in perfect order, testing every thermostat and every inch of wire in the whole system. An engine, 25 horse power, is used to run the ensilage cutter, feed mill, elevator, and saw. A line of shafting runs through the ell part of the barn, with sufficient number of belt pulleys on to run each piece of machinery. All journal bearings are protected by a thermostat, and should heat rise to 140°, alarm will sound by the ringing of a bell over the door to the engine room, where there is an indicator showing upon which shaft the journal is hot.

The steam for the engine is conducted to it under the ground from the power house, which is situated about 300 ft. away. There is a bone mill, so that they can grind meat and bone for their chickens. The elevator for elevating grain into the bins is of the Jeffres patent, and has a capacity of 300 bushels an hour. The feed mill is so arranged that the grain can be let in the hopper in just the proportion they wish to grind, when the elevator carries it back to the bins, ground, when, with chutes, it is loaded in cars and conveyed to the cattle in their stalls and fed to them as desired.

All the work of rebuilding has been under the superintendence of Mr. H. M. Cottrell, superintendent of Ellerslie, who has given his immediate attention to all the work in detail, and the success of the building and rapidity with which it was constructed was all due to him, and it will pay any person who wants to spend a short time pleasantly to visit the barn and see the many improvements developed in its building.

### THE BROODER HOUSE AT ELLERSLIE.

At the time Ackert & Brown were building the barn they had a gang of men building an incubator and brooder house, one of the largest and best in the United States. This department is under the immediate supervision of Mr. James H. Seeley, who has had Mr. Morton's chickens in charge for nearly two years. When the fire came which destroyed the barn last year, it also destroyed the incubator and brooder houses with all the stock of chickens. When they got ready to rebuild, they located the buildings farther away from the barn. They began the first plant in August last, by building 6 hen houses, to accommodate 600 laying hens. Sufficient number of hens were bought to start with, and then came the erection of brooder houses to raise and care for the small chickens, which are to be hatched with incubators and raised for fancy market broilers and larger ones for roasting.

The hen houses are fitted up with electric wire, and no person is allowed or can cross the threshold of the door or open the windows without ringing a bell in the house; also it will ring a bell in the room in the incubator house, where the man sleeps. Chicken thieves stand a poor show to get a living around these houses. They are built for winter laying hens. The size of the hen houses are 16 by 54, made in three sections, two rooms in each section, one room for laying and roosting, the other one is for exercise on bad, snowy, or stormy weather, there being no floor but the ground. Down under the top of the ground is placed wire netting to prevent rats from getting in or making a home in the building. The room for laying is fitted up with movable nests, 12 in number; in each cabinet and in each room are crates to confine hens that want to set, as they have no use for setting hens; the incubators do all their work.

All hens purchased are white Monarchs, white Plymouth Rocks, white Wyandotts, sprinkled with a few light Brahmas. It is wanted to have hens enough to

lay eggs to supply the incubators, which require 150 daily.

The brooders and incubator houses are located in the same space of ground, between the six hen houses, is perhaps the largest plant of the kind in the United States.

The two brooder houses are 132 ft. long by 18 ft. wide, and are fitted up with all the improvements and labor saving devices. In each of houses there are 25 pens, 5 ft. by 15 ft., which will accommodate 2,500 chickens. There is a 3 ft. hallway running in front of the pens to feed from, also being very convenient to do all the necessary work. In each pen there is an artificial brooder, heated with hot water pipes, it requiring half a mile of hot water pipes in these houses to give the necessary heat from a Gurney hot water heater.

The pens are furnished with water fountains, feed troughs, and boxes for dust and ground. The floors are of spruce, underneath which is fine hardware cloth, to prevent mice and rats from getting the young chickens. The frame is of planed hemlock, and a lantern is placed in the center of each building which furnishes light and ventilation. The sash is operated by a device from the hallway, and opens six windows at once. Each pen has a window and also an opening to let the chickens out into the yard on the south side of the houses. The slides are placed upon a movable frame, and with one pull of a lever in the incubator house, every pen can be opened or closed at once, and, by changing the slide, any number of pens can be opened or closed at will. In each house there are five solid partitions of wood, so that one part of the brooder can be shut off from the other, and the partitions between pens are of 1 in. mesh wire, and about 20,000 ft. of wire was used in brooder houses and yards.

The brooder houses have a capacity for 5,000 chickens at once, and they will be graded from the chickens just taken out of the incubators to those weighing 4 or 5 pounds. Mr. James H. Seeley, the manager of this department, aims to produce all white chickens for market. The incubators are heated with gas from a gas machine, being in every way complete, heating the incubators accurately, at the same time furnishing light for the building. There are 10 Puieland incubators in this building, with a capacity of 300 eggs each, and when the plant is in full operation, it will require three men, besides the manager, to do the work and care for the hens and young chickens. They expect to raise 20,000 broilers a year. The duck house is east of the brooder house, and the young ducks will be hatched out in the incubators, and they expect to put upon the market 5,000 ducks annually, all of the white Pekin variety. The incubator house has, besides the room for incubators, an office for the manager, feed rooms for mixing and storing feed, a picking room, a room for gas pump and weight, and a hallway connecting all rooms with brooder house and stairway to bedroom.

This plant is under the immediate supervision of Mr. James H. Seeley, and of course we know it is in good hands, as he is an encyclopedia on chickens.—*The Rhinebeck Gazette.*

## COYOTE FARMING IN KANSAS.

For years the Western prairies have been fruitful in the production of that fleet-footed nuisance, the coyote. Surpassed in speed only by the antelope and particularly fast greyhounds, it is practically secure from harm. In order to keep down their rapidly increasing numbers, the Kansas legislature authorized in 1889 the offering by counties of a bounty for wolf scalps. Nearly every county in the State seized the opportunity and gave, in order to protect flocks and chicken yards, a reward of $3 to $4 per scalp. The result has been astonishing. Men have discovered that it paid better to hunt wolves than to raise crops, and several frontier counties have paid from $3,000 to $4,500 a year in bounties, the total in the State reaching $60,000, with no appreciable diminution in the coyote supply.

This fact puzzled the commissioners of several counties, until it was discovered that farmers were making a business of raising wolves for the bounty to be secured. By means of wire fence inclosures with ample burrowing grounds, the creatures increase with marvelous rapidity. The growth of a family of kittens can alone be compared to them. For feed, the cheapest of meat is sufficient, and as nothing is required but the scalp in order to draw a bounty, the carcasses of the killed wolves are used for sustenance for those not ready for market. The best sheep that the prairie farmer can raise can scarcely be sold for more than $2. To produce several litters of wolves a year, each member of which is worth from $3 to $4 exclusive of skin and carcass, is, it is seen, remunerative.

These wolf raisers also supplement their home supply by constant hunting on the plains. Parties are formed which surround creek valleys and ravines, "beating the brush" with as much skill as the trained retainer, and capturing, dead or alive, dozens of the lank, gray creatures. The former go to swell the cash account of the hunters and deplete that of the county treasury, while the latter are added to the supply on the wolf farm.

To hunt the coyote by means of native dogs is something humorous. No matter how fleet is the dog, it always has some of the conceit taken out of it when hunting coyotes. Once aroused to its danger, the Ishmael of the plains, lonely, stern and forsaken, takes its course over the level prairie at a rate which discourages the bravest. As Mark Twain says of the coyote of the alkali desert, it "cuts a long crack through the atmosphere, and the dog is suddenly alone in the midst of a vast wilderness." With greyhounds it is different. Their long, slender legs can overtake the fleetest of the plain's creatures, and the sport has become a fascinating one to the members of kennel clubs throughout the West.

Probably the most remunerative hunting is that by means of half-mile wires introduced by a New England land sportsman this winter on the prairies of western Kansas. Hitching a team to each end of a half-mile strand of wire, it is dragged over the curling buffalo grass, with a row of sportsmen, their guns ready for instant use, scattered behind it in a long row. The coyotes, rabbits, foxes, and prairie dogs, crouching low in their fancied security, are roused from their hiding places and go skurrying here and there ahead of the remorseless wire. When the cavalcade has made a half day's progress, the wire is swung around and another course taken homeward. Parties have in this way killed as many as a thousand jack rabbits in a single day and sent them to the charitable societies of Western cities. The harvest of coyotes has also been large, and the bounties received have made good return for the day's amusement.

Altogether the prairie wolf has proved a very profitable creature to the Westerner—so profitable in fact that it is likely that the legislature will be compelled to repeal the bounty laws, and farmers who have been making $500 to $1,000 a year out of the wolf industry will be driven out of business.—*St. Louis Globe-Democrat.*

## THE FEIGNING OF DEATH BY ANIMALS.

The feigning of death by certain animals, for the purpose of deceiving their enemies, and thus securing immunity, is one of the greatest of the many evidences of their intelligent ratiocination. Letusimulation (from *letum*, death, and *simulare*, to feign) is not confined to any particular family, order, or species of animals, but exists in many, from the very lowest to the highest. It is found even in the vegetable kingdom, the well-known sensitive plant being an interesting example. The action of this plant is, however, purely reflex, as can be proved by observation and experiment, and is not, therefore, a process of intelligence. The habit of feigning death has introduced a figure of speech into the English language, and has done much to magnify and perpetuate the fame of the only marsupial found outside the limits of Australasia. "Playing 'possum" is now a synonym for certain kinds of deception. I have seen this habit in some of the lowest animals known to science. Some time ago, while examining the inhabitants of a drop of pond water under a high-power lens, I noticed several rhizopods busily feeding on the minute buds of an alga. These rhizopods suddenly drew in their hairlike filaria and sank to the bottom, to all appearances dead. I soon discovered the cause in the presence of a water-louse, an animal which feeds on these animalcules. It likewise sank to the bottom, and after looking at the rhizopods swam away, evidently regarding them as dead and unfit for food. The rhizopods remained quiet for several seconds, and then swam to the alga and resumed feeding. This was not an accidential occurrence, for twice since I have been fortunate enough to witness the same wonderful performance. There were other minute animals swimming in the drop of water, but the rhizopods fed on unconcernedly until the shark of this microscopic sea appeared. They then recognized their danger at once, and used the only means in their power to escape. Through the agency of what sense did these little creatures discover the approach of their enemy? Is it possible that they and other like microscopic animals have eyes and ears so exceedingly small that lenses of the very highest power cannot make them visible? Or are they possessors of senses utterly unknown to and incapable of being appreciated by man? Science can neither affirm nor deny either of these suppositions. The fact alone remains that, through some sense, they discovered the presence of the enemy, and feigned death in order to escape.

Most animals are slain for food by other animals. There is a continual struggle for existence. Most of the carnivora and insectivora prefer freshly killed food to carrion. They will not touch tainted meat when they can procure fresh. It is a mistake to suppose that carnivora prefer such food. The exigencies of their lives and their struggle for existence often compel them to eat it. Dogs will occasionally take it, but sparingly, and apparently as a relish, just as we eat certain odoriferous cheeses. But carnivora and insectivora would rather do their own butchery; hence, when they come upon their prey apparently dead, they will leave it alone and go in search of other quarry, unless they are very hungry. Tainted flesh is a dangerous substance to go into most stomachs. Certain ptomaines render it sometimes very poisonous. Long years of experience have taught this fact to animals, and therefore most of them let dead or seemingly dead creatures severely alone.—*Atlantic Monthly.*

## A REMARKABLE COMETARY COLLISION.

Two striking photographs are reproduced in the February number of *Knowledge* in illustration of an article by Prof. E. E. Barnard on the probable encounter of Brooks' comet with a disturbing medium on October 21, 1893. The comet was discovered by Mr. Brooks on October 16; but, though it was kept under observation at the Lick Observatory, no phenomena of an extraordinary kind were observed until the 21st of that month. A photograph, then taken with a Willard photographic lens, presented a remarkable appearance, the tail appearing, to use Prof. Barnard's analogy, like a torch streaming in the wind. The reproductions of the photographs give the impression that the comet's tail swept into some dense medium and was broken up by the encounter. Indeed, Prof. Barnard thinks it impossible to escape the conclusion that the tail did actually enter a disturbing medium which shattered it. This theory is supported by the photograph taken on October 22, where the tail is seen to hang in irregular cloudy masses, and a large fragment appears to be entirely separated from the main part. There is little doubt that the tail met a mass of meteoritic matter and so had its symmetry destroyed; at any rate, this supposition must be accepted until a simpler and better one can supplant it. What we have to do, as Mr. Cowper Ranyard remarks in an article on the irregularities of comets' tails, is diligently to collect facts. The multiplication of such photographs as those obtained of Brooks' comet and of Swift's comet (1892) by Prof. Barnard, will certainly revolutionize current opinion as to the development and the types of comets' tails.

A recent note from Canisteo, N. Y., contains the following:

The well recently drilled at this place by the Canisteo Oil and Gas Company, after it was shot, for some days produced no oil whatever, but a few days ago it began to show signs of oil, and has since produced about five barrels a day of lubricating oil. A peculiar thing about the product is that when a piece of white cloth is immersed in it and exposed to the light it at once turns a bright blue color, which is permanent. A committee of chemists has been appointed by the company to analyze the oil and choose a name for it. Parties engaged in the manufacture of calico in Oswego are negotiating with the owners of the well with a view to using the oil for dyeing purposes.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## THE MEDICAL CONGRESS AT ROME.

At the recent Medical Congress (eleventh), held March 29, 1894, at Rome, 7,612 members registered. The first congress was held at Florence, in 1869, with an attendance of only 350. In the present congress the lead was naturally taken by Italy, which furnished 1,200 members, Germany came next with 900, followed by Austria-Hungary and the United Kingdom with 700 each. France came next with 600, followed by Spain with 250, Russia with 200, and the United States with 170, which is a very good showing, considering the time and expense required to reach Italy from America. The time was filled up by general papers, by special papers read before the various sections, and by entertainments furnished by the hospitable Romans. We illustrate the fete held in the Baths of Caracalla, and also give a portrait of M. Baccelli, president of the Medical Congress, for both of which we are indebted to *L'Illustration*, also a sketch of the opening scene from the *Graphic*, London.

The garden party at the Quirinal Palace and the lunch in the Baths of Caracalla will doubtless leave an indelible impression on the minds of the members of the congress. The gardens of the Quirinal possess great beauty and dignity, and were admirably adapted to hold the three thousand invited guests. A red and yellow pavilion, partly rustic, partly oriental, formed the reception room. Two orchestras, two buffets, and a dancing pavilion were installed in the garden. The king and the queen descended the steps of the palace, followed by their gentlemen and ladies of honor. Many of the *savants* and their wives or daughters were presented to the queen. The garden party was an aristocratic fete; not so the lunch. Twelve thousand invitations were issued. In this Pantagruelian feast the total amount of provisions consumed was enormous. Two deer, forty lambs, forty kids, four hundred pieces of beef, one hundred hams, two thousand five hundred chickens, twenty thousand cakes, forty thousand Vienna rolls, twelve tuns of wine, nine thousand bottles of wine, besides ices, coffee, etc., were consumed by the hungry crowd—truly a Roman orgy. Precisely at noon the barriers were thrown down and the assault upon the tables began. Naturally, half the guests went hungry, for in thirty minutes nothing was left but *debris*. After the lunch the guests examined the enormous ruins, the gigantic proportions of which never cease to cause wonder.

M. Baccelli, President of the Medical Congress, Rome.

Professor Baccelli, upon whose eloquence endless calls were made throughout the week, made an apt little speech. "From these glorious ruins," he said, "the spirits of ancient Rome rise for you to-day. She trusts that by your talents you will perpetuate her glory. In this immortal city, which once ruled the world with the sword, to which nations and their kings were dragged as prisoners, to-day and along this same *Via Sacra* welcomes all that is most advanced in human knowledge. It is a new *via sacra* of liberty and science."

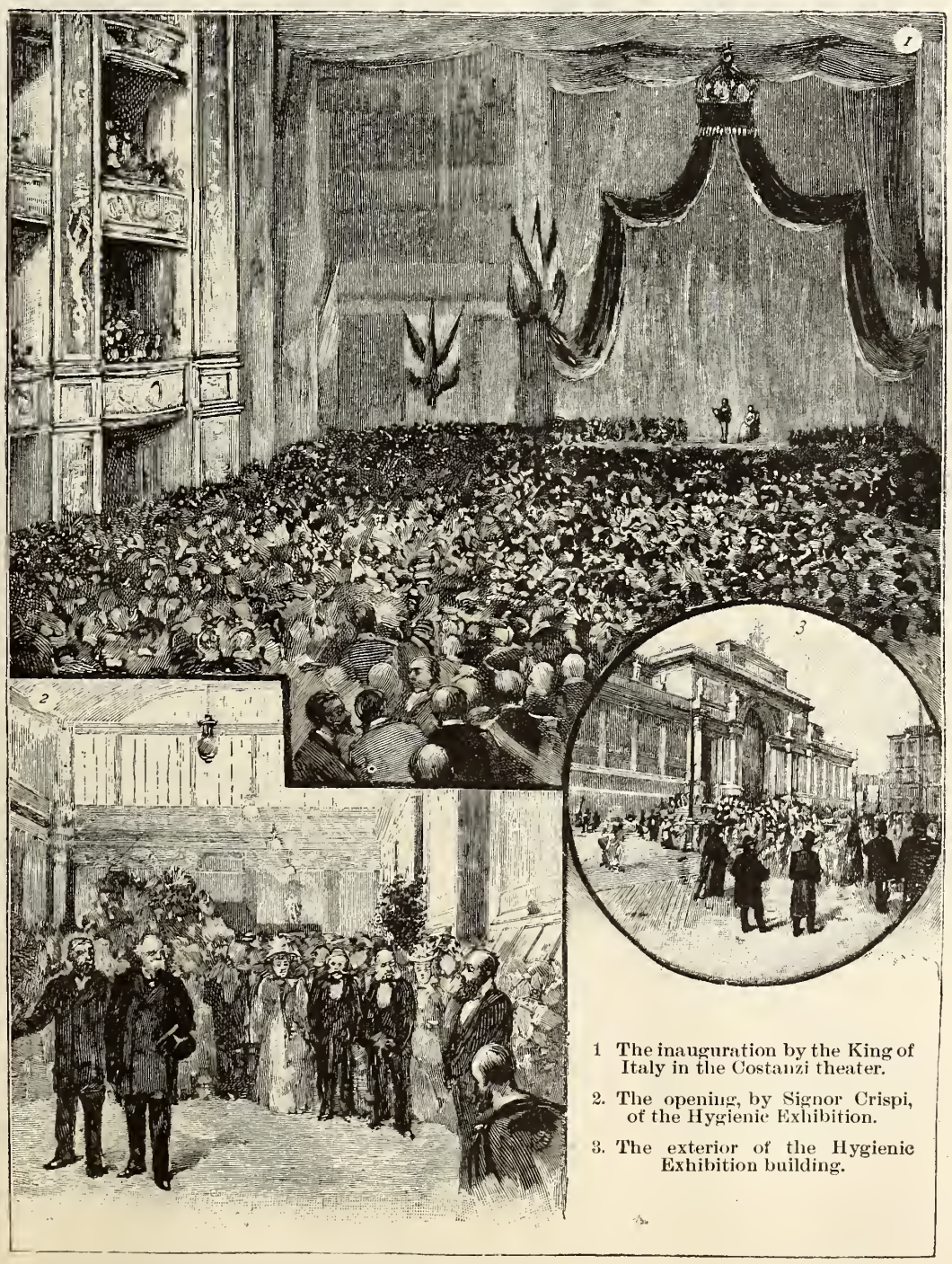
Hundreds of valuable papers were read in the different sections. From the *Medical Record* we take the following:

Dr. Luigi Cantu, of Pavia, in a paper upon the influence of temperature upon intestinal fermentation, said that he had several times observed a syndroma of phenomena consisting essentially in severe and painful cramps of the stomach, nausea, vomiting, wandering abdominal pains, borborygmi, slight fever, etc. At the same time the skin of the entire body was covered with the characteristic eruption of urticaria. The troubles disappeared completely in four or five days. The symptoms were referred by the author to auto-intoxication of intestinal origin, caused by an exaggerated peristalsis of the stomach, and secondarily of the intestine, excited by rapid oscillations of the atmospheric temperature acting upon the abdominal region. He had observed the same morbid complex in persons who had slept with abdomen uncovered in a room, the window of which was open during the night. Upon measuring in these individuals the intensity of the fermentative processes by the dosage of sulphonic ethers in the urine, he had found these processes always greatly increased. He had found, however, that the application of ice bags to the abdomen retarded digestive fermentation to a marked degree, and this would furnish an indication for their use in attacks similar to those above described.

Dr. Burney Yeo, of London, presented a communication upon the management of fevers and particularly of typhoid fever, of which the following were the conclusions: 1. Recently acquired knowledge as to the nature and causes of specific fevers demands a modification in the therapeutic conceptions and indications applied to their management. 2. To counteract or antagonize the pyrogenic and other poisons secreted by micro-organisms introduced into the body from without is an essential therapeutic indication in the treatment of fevers. 3. The investigation into the existence, scope, and activity of such counteracting therapeutic agents is of paramount importance to the rational treatment of fevers, and already the results of clinical observations give promise of fruitful conclusions to researches in this direction. 4. The search for direct antagonists to the poisons of specific fever is as important and probably of as great practical advantage as is that for methods of producing immunity. 5. The course and character of specific fevers can be, and have been, favorably modified and influenced by the administration of such antagonists. 6. Certain specified methods commonly adopted in the management of fevers, and especially of enteric fever, require modification and correction (*a*) in the direction of diet and regimen, and (*b*) in the direction of drug treatment.

Dr. Juhel-Renoy, of Paris, read a paper on the treatment of the typhoid state, of which the following were the main points: all infectious diseases may assume the typhoid aspect, and when this occurs refrigerant treatment is indicated. The method of this refrigerant medication must vary according to the result which it is desired to obtain. It is vastly superior to any other procedure in all forms of infectious fever; it reduces the total mortality of typhoid fever to seven per cent.; of typhoid erysipelas to nine per cent.; of malignant scarlatina to fourteen per cent.; of ataxo-adynamic measles to an almost inappreciable figure. The mortality of adynamic grippal pneumonia is reduced one-half by cold baths, and smallpox, when treated in this way from the start, is much milder in its course. The ways in which cold baths bring about the disappearance of the typhoid condition are numerous, but that which seems to be the most important as well as the most constant is the urinary crisis, an indication, when it occurs, of an early cure.

Dr. H. Chiari, of Prague, read a paper on typhoid bacilli in the gall bladder, in which he said that the systematic bacteriological examination of the contents of the gall bladder in cases of enteric fever almost always revealed



1 The inauguration by the King of Italy in the Costanzi theater.

2. The opening, by Signor Crispi, of the Hygienic Exhibition.

3. The exterior of the Hygienic Exhibition building.

THE INTERNATIONAL MEDICAL CONGRESS AT ROME.

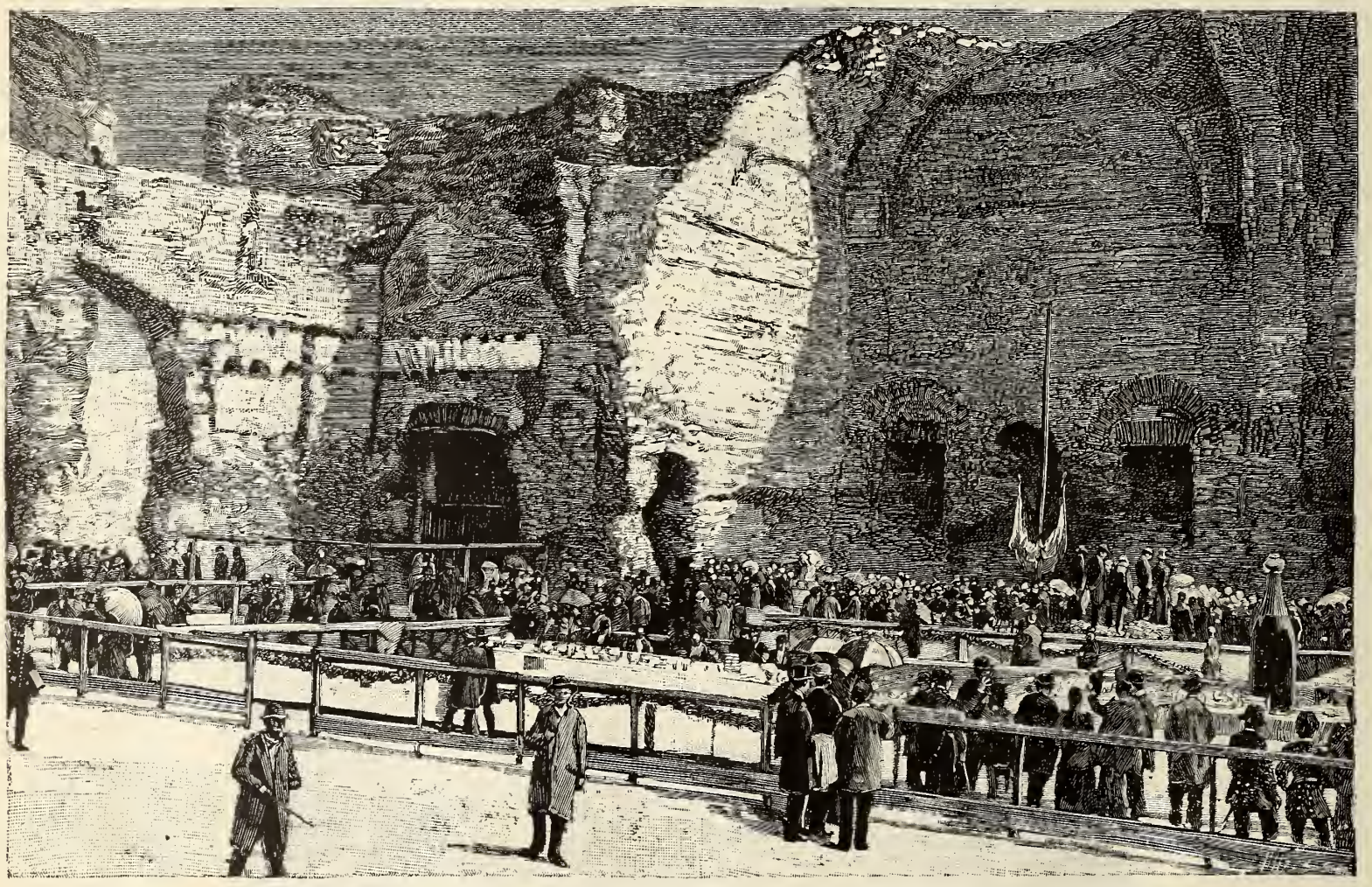
the presence of typhoid bacilli. The bacilli may increase in numbers here and induce an inflammation of the gall bladder, and possibly there is in this fact an explanation for certain cases of relapse in typhoid fever. The bacilli gain entrance either through the blood or by direct ascent through the common bile duct from the intestine.

## ARCHÆOLOGY AND MEDICINE IN ROME.

By Commendatore RODOLFO LANCIANI, Professor of Roman Topography in the University of Rome.

OUR knowledge of the progress of medicine and of the scientific value of medical men among the Romans rests more on the authority of classic writers than on the evidence of monuments connected with the *ars medica* lately discovered in our excavations. From this point of view the field is practically unexplored. Facts have been collected by Lancisi, Marini, Bernegau, Ackermann, Hebensteckt, Necker, De Mattheis, Brian, Marchi, Pericoli and by myself,* but they have yet to be brought together and compared with the results of recent discoveries. The "Esposizione d'Igiene," organized in connection with the present Medical Congress, contains many remarkable specimens illustrating the practice of medicine and surgery in ancient times, the sanitation of ancient cities, etc., but by far the greatest number of these objects lie still unknown in public and private collections. I have for many years advocated the institution of a central Museo d'Igiene for the exhibition and study of monuments pertaining to the cremation and inhumation of men, to the regulations of cemeteries, to drainage and water supply, to the sanitation of the Campagna, to the worship of healing gods, to gymnasiums, baths, to the practice of surgery and dentistry, to hospitals, etc. The materials for the institution are all ready, and if we should require more, we know where to find them. It was customary in ancient times for persons cured of their ailments by the skill of priest doctors or by the value of thermal waters to put up a votive offering as token of gratitude to gods and men. Each sanctuary hospital, therefore, was furnished with one or more rooms for the exhibition and safe keeping of ex-votos. The walls of these rooms were studded with nails, on which ex-voto terra cottas or tablets were hung by thousands. When every inch of space was filled and no room left for the daily influx of offerings, the priest removed the collection and buried it either in the vaults of the temple or in trenches dug for the purpose. In case of a watering place the offerings were thrown at the bottom of the spring. Many such mines of ex-votos have been explored in recent times at Vicarello (*aquæ Apollinares*), at Nemi (*templum Dianæ, seu Artemisium Nemorense*), at Veii (*templum Junonis*), at Rome, in and around the island of S. Bartolomeo, where the Temple of Æsculapius stood. The discovery of the deposit of Vicarello took place in 1852. In draining the main spring for the purpose of cleaning it from incrustations which had nearly choked the orifice, the Jesuit fathers, to whom the place belonged, came across a layer of brass and silver coins of the fourth century after Christ. It was followed by a stratum of gold and silver coins of the empire, mixed with silver drinking cups on which various itineraries (from Cadix to the Springs) were engraved. The third layer was composed of Republican coins; the fourth of shapeless fragments of copper (*æs rude*); the fifth, at the very bottom of the well, of flint implements offered to the local god by the half savage people settled in that neighborhood long before the foundation of Rome. The exploration of the seam of ex-votos at Veii began two and a half centuries ago, at the time of Pope Alexander VII., and is not yet finished. The ex-votos from the local sanctuary of Juno were not buried in a *favilla*, but thrown from the edge of the cliff on which the temple stood into the valley of the Cremera. In 1889 I was able to make a rough estimate of the size of the deposit: 250 feet in length, 50 feet in width, and from 3 to 4 feet in depth—nearly 44,000 cubic feet. The vein contained fifty-two varieties of types—busts, masks, arms, breasts, wombs, spines, bowels, lungs, toes, genital organs, figures cut open across the breast and showing the anatomy, arms, legs, feet, etc. It is a great pity that these materials for a comparative study should have been scattered far and wide, and that no scientific or systematic search should have been attempted. Ample opportunity, however, is still left to mend matters and regain the time lost. The bed of the Tiber around the island of Æsculap contains superb specimens of anatomical preparations in terra cotta. The exploration of the springs of the *aquæ albulæ* has never been attempted, nor that of the lake Gabii. Tombs of surgeons and oculists abound in tools of the trade, or in recipes of various kinds. Skulls show occasionally curious evidence of dental operations. The exhibition held in the Palazzo delle Belle Arti in the Via Nazionale shows what can be accomplished in this line even in a short time.—*Lancet.*

* Lancisi: De Advent. Rom. Cœli Qualit. Marini: Gli Archiatri Pontificii. Bernegau: De Servi Medici apud Græcos et Romanos Conditione; Halæ, 1733. Ackermann: De Antonio Musa Augusti Medico. Hebensteckt: De Medicis Archiatris et Professoribus. Necker: Storia Filosofica Antica della Medicina; Firenze, 1852. De Mattheis: Dissertazione sul Culto della Dea Febre. Brian: L'Assistance Medicale chez les Romaines; Paris, 1869. Marchi: La Stipe Sacra delle Acque Apollinari. Pericoli: L'Ospedale di S. Maria della Consolazione; Imola Galeati, 1879. Lanciani: Ancient Rome; Boston, 1887.



THE MEDICAL CONGRESS, ROME—THE LUNCH AT THE BATHS OF CARACALLA.

## MICROTOMY.

THE art of microtomy is really the finest of all fine arts. Indeed, so exquisitely delicate is it that it would seem to have hitherto escaped even the subtile appreciation of the amateur, who rangeth where he listeth, knowing all things and believing all things. The public is unfamiliar with the name of the art; the fame of the microtomist is not noised abroad. Those who appreciate the little glass slips with "Cole Deum" thereon, the quaint motto of the elder Cole, are less in number than those who gather walking sticks or rejoice in the tracing of brasses, says the *Pall Mall Budget.*

Indeed, collecting is almost unknown, though why people should collect stamps and leave these things alone surpasses our imagination. A day will come, however, when slides for the microscope by the early masters who are even yet living will be as eagerly sought and fondly treasured as were ever book plates or violins. Pity it is they worked in Canada balsam, which has the trick of decay.

It is even possible that the reader needs to be told what this microtomy may be. It is, poor soul, the delightful art of cutting inconceivably thin sections of every conceivable substance. There is nothing one may not cut, save one's friends—your fingers always volunteer of their own accord, sooner or later; but some things are unlawful (as, for instance, the coin of the realm), and some are not convenient (as the tail of a live lion). Moreover, the thing cut must be mounted cunningly on a glass slip, for the end for which the section exists is to be examined under a microscope.

If one would see some microtomist's work, let him seek a medical student possessed of a microscope. The same will show him a number of glass slips three inches long, perhaps, by three-quarters wide. These will be labeled—one "Muscle;" another, "Sciatic Nerve;" a third, "Scalp of a Child;" and a fourth, "Cat's Liver." Such names do not lead one to anticipate art and beauty, and this makes the art and beauty all the more charming.

In the center of each of these slips, covered by an extremely thin circular disk of glass, he will see a little slice of matter, the size, perhaps, of the head of a tin tack or smaller, and so thin as to be altogether transparent. This is, let us say, your cat's liver etherealized by the microtomist. Under the microscope it has the air of a circular stained glass window; the "cells" of the liver form an interlacing tracery of golden pink, and the diverse blood vessels, of which there are three sorts, appear, if injected, as branching shapes of crimson, blue and other sweet and pure colors, even such as the Madonnas of the old masters wear. The scalp may be even more delightful, with its hair like stout brown masts, a greenish cuticle and sunset tinted sub-dermal tissue below.

It is obvious that with such an infinite variety of material the microtomist must needs have a great variety of instruments. Some things he cuts with a common razor in his hand; such must needs be of a firm consistency, neither flabby nor brittle. Some again—larger things—he cuts with a plane. Little things he cannot hold he embeds in wax or carrot or the pith of the elder, and so gets a fingerful that may be grasped and cut. A soft substance, such as human muscle, he hardens by the immersion of a lump of it in a suitable fluid; or he takes it fresh and almost living, and freezes it firm upon a metal slab by means of ether.

A rock is cut into thin slices by a lapidary's wheel, a rotating disk of steel made keen by rubbing diamond powder on the edge, and these slices are stuck to a piece of glass and gradually rubbed thinner and thinner upon emery powder of increasing fineness, and finally upon rouge. Powdery things like sand grains the microtomist overcomes by embedding in hard substances. He particularly dreads and rejoices over such brittle substances as coal. One would expect mere blackness of coal even at its thinnest, but there are certain coals from Scotland which, when cut, reveal myriads of little flattened cases of a streaky orange or lemon yellow color, the spore shed long since by the trees which perished to form our coal seams.

There are in London, perhaps, half a hundred or more human beings who live by this unknown art. One we know of plies his trade in a little den high above the roar of the Strand. He sits at his window facing the light, wa ch glasses and little shallow dishes full of stains around him, microscope and micrometer ready to hand, sometimes amid a heavy aroma of ether from the freezing microtome, and sometimes reminding one oddly of pine trees and wide mountain slopes, with the resinous smell of his Canada balsam. All about him are little bottles—innumerable little bottles—labeled "skin of toad," "orange pips," "pine inflorescence," "lancelet," "kitten's lung," "tumor," and the like, or, rather, unlike, some of them fit ingredients for the brew of the witch. One whole shelf presently catches the eye, labeled "Mrs. Webster," and in smaller letters the part of Mrs. Webster is specified.

He relates a grewsome story in a tone of pathetic regret; how this Mrs. Webster was a landlady of his

who died suddenly—"poor old lady"—and was "post mortemed" by a confidential friend. "So I took these little mementos," he says, waving his hand at the shelf. It is a grim and sordid fate for a landlady that she should be peculated by her own lodger and retailed at 6d., 9d. and 1s. a slice, according to the choiceness of the parts. But there are those who suspect our microtomist of having obtained his human material in a legitimate way from the dissecting room, and having created his Mrs. Webster for literary effect.

Still the jumble of matters in the corpulent little bottles upon his shelves remain odd enough; pickled organisms from the deep sea are side by side with scraps of plant, root and stem, and the mortal remains of a pet puppy; while a fruit that grew and ripened in a jungle in Borneo shares a bottle with some cubic inch of substance that was once part of the vestiture of a human soul in a London hospital. Sooner or later they will come to the knife edge and the glass slip. Our microtomist is, indeed, on the level of Shakespeare. All being pays its tribute to his art; he makes it clear and brilliant for us, using his stains and media not to hide but to display, making truth truer and the visible plain. His work is a veritable microcosm—a summary of the world.

The ordinary microtomists who cut sections for the medical students, as a rule, do little in the direction of cutting rocks. This has a special technique, and is practiced chiefly at the greater geological schools—at the Royal School of Mines, for instance. It is almost impossible to convey an idea of the appearance of sections of some granite rocks when seen in polarized light. Let the reader think of the tints of a film of gas refuse floating on water, of the spectrum thrown by a glass prism, of fire opal, of the mother-of-pearl, of old stained glass windows, of Burne-Jones at his best. All these, and more also, will he see in such a rock as picrite or dunite. A day will come when artists will seek these things and learn a thousand delights of coloring from their study, for microscopic sections may be collected for their beauty, for their technical excellence, thinness, and so forth, for their historical interest and for scientific importance.

## ON THE ACTION OF ALUM UPON THE NERVOUS SYSTEM.

THE modern development of chemistry has undoubtedly been of the greatest possible service in arts, manufactures, and in medicine, but, like all good things, it is not without its disadvantages, and sometimes it may lead to evil, the cause of which may remain long unsuspected. It is possible that this may be the case with some of the nervous diseases whose causation is frequently attributed to hurry, worry, and nervous strain, due to an advancing civilization. There is no doubt that the introduction of the penny post, railways, and telegrams has very greatly increased the strain upon the nervous system, but still we can hardly attribute to them some of the obscure nervous diseases from which some people suffer, while a very large number more who are subject to the same strain remain uninjured. The number of the factors which may be concerned in producing nervous disease has hitherto rendered it impossible to trace these diseases to their exact source. Of late years there has been a tendency to recognize a likeness between the symptoms of certain nervous diseases and those produced by poisons; and, as Dr. Sidney Martin showed very clearly in his Goulstonian lectures, the paralysis which follows diphtheria is not due to the microbe of the disease, but to a poison produced by it which will cause nervous degeneration and loss of power when separated from the microbe and injected into an animal. The poison produced by the diphtheria bacillus appears to belong to the class of toxalbumins, but in his researches on anthrax poison Dr. Martin showed that from the anthrax virus an alkaloidal substance could be separated which had a lethal action like that of the ordinary virus itself.

In the Croonian lectures for 1889, Dr. Lauder Brunton pointed out the likeness between the symptoms of disseminated sclerosis and locomotor ataxy in man and those produced in frogs by poisons belonging to the benzine series, and such observations indicate the possibility of certain nervous diseases being caused by the absorption of poisonous products of albuminons decomposition in the intestines. Certain inorganic substances are well known to cause nervous disease, examples of which are lead palsy and mercurial tremor, affections which are readily traced to the poisons producing them. Hitherto, however, no attention has been directed to alum as a possible cause of nervous disease, and yet the symptoms it produces on the nervous system after its absorption into the blood are very remarkable indeed. They were apparently first noticed by Orfila, who found that when alum was given to a dog, and vomiting prevented by ligature of the gullet, death occurred, with symptoms of weakness and diminished sensibility, so that it was almost impossible for the animal to stand upright, and pinching or pricking caused no movement.

The most complete series of experiments on the action of aluminum salts were made under the direction of Professor Hans Mayer by Paul Siem. These experiments showed that when administered to animals (dogs, cats, and rabbits) by subcutaneous injection, a soluble salt of alum causes no symptoms at all for three or four days. Then the animal suffers from loss of appetite and obstinate constipation, emaciation, languor, and disinclination to move. Next there is vomiting and loss of sensibility, as a deep prick with a needle is scarcely felt. When forced to move the leg is raised, but trembles and twitches violently, and is with difficulty placed on the ground. Sometimes there is general tremor or convulsive twitching, and sometimes there is extreme weakness or partial paralysis of the posterior extremities. There is complete loss of sensibility to pain, while the animal retains its senses. Then the power of moving the tongue and of swallowing is completely lost; even the saliva cannot be swallowed. The symptoms are precisely those which are observed in a disease occurring in man, and known under the name of acute bulbar paralysis. The cause of this disease in man is at present unknown, and the idea of its possible connection with the continued absorption of alum in the same way that lead palsy or mercurial tremor may be due to the absorption of lead or mercury is quite a new one. Much observation may be necessary in order to ascertain whether such a connection exists or not, but the disease is so dreadful and its treatment so hopeless that it is worth while for physicians generally to try whether such a causal connection between the use of alumina and the appearance of the disease can be traced. It is probable that many medical men are unaware of the extent to which salts of alumina may be introduced into the body, because they are under the impression that the use of alum in bread is forbidden by law, and that, as this element hardly exists to any extent in any potable waters, they may consider that its introduction into the body is impossible.—*British Medical Journal.*

## APPLICATION OF ANTISEPSY TO HYPODERMIC MEDICATION.

WHO has not seen, if he has not employed for himself, the morphine syringe, whose sharp needle, through a slight puncture, gives repose, calmness and sleep to the sick almost instantaneously? One might inscribe upon its case, as a motto: *Divinum est opus sedare dolorem.*

So many advantages are not unaccompanied with some inconveniences. Without speaking of the abuses that may follow a too prolonged use of it, it must be known that the germs that surround us, on every side, microbes and fungi and internal parasites, may invade solutions or develop in the syringe and its needle. Thus arise erythema, painful induration, abscess in light cases and phlegmon in grave ones, erysipelas and purulent infection.

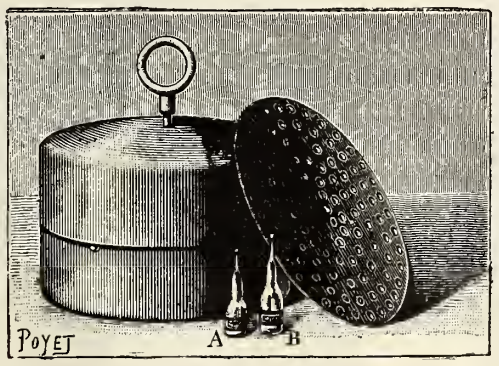



FIG. 1.—STERILIZED TUBES, A B, AND SILVER PLATED RECEPTACLE.

In order to suppress such accidents, Messrs. Duflocq and Berlioz propose to combine the use of sterilized tubes with that of a quickly sterilized syringe. The tubes, which are made of yellow glass in order to prevent the action of the light, contain, some of them, half a cubic centimeter of liquid, and others a cubic centimeter.

They have the form of a small bottle (Fig. 1, A B). Fig. 4 represents them of natural size. Their slender neck is composed of two parts. The first, *c*, gradually tapers to *a*, where it joins the second, *e*, which is much more slender. At the moment of using, the breaking

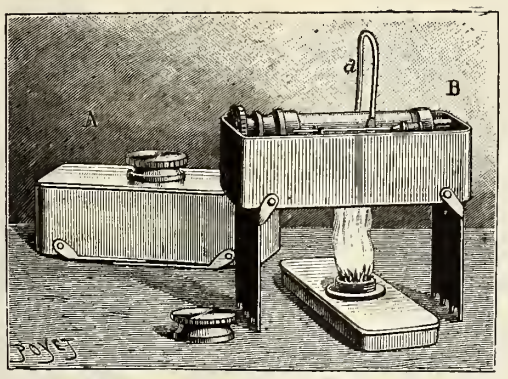



FIG. 3.—SYRINGE INCLOSED IN THE STERILIZING BOX.

A, apparatus closed; B, the same open.

is necessarily effected at the fragile point, *a*. Into the aperture thus formed it is necessary to introduce the needle of the previously sterilized syringe, to invert the tube in holding the syringe vertically, and to suck in the liquid. It then suffices to expel the air, and observing the graduation of the rod, to fix the quantity of liquid that one desires to inject.

For filling the tubes, a round vessel of silvered metal (Fig. 1) is used and into which is poured the accurately titrated solution, the vehicle of which is distilled water. Above there is placed a perforated metallic diaphragm into the apertures of which are inserted the slender neck of each tube, the point of which enters the liquid. The cover is put on and the whole is placed in a heating apparatus and left therein for twenty minutes at temperature of 120°. After cooling the apparatus is placed under a bell glass which is put in communication with an air pump, through whose operation a vacuum is created in the bell glass and in the tubes, the air in which escapes in bubbling up through the liquid. The air is afterward allowed to re-enter in filtering it through sterilized wadding, and the pressure of the atmosphere, acting upon the surface of the liquid, forces it to ascend into the tubes. These latter are then sealed, one by one, by means of a lamp. As all manipulation is suppressed, it will be seen that it is impossible, under such circumstances, that the solution shall be contaminated at any moment.

These perfectly aseptic tubes are therefore capable of being preserved for an indefinite period. Thus it will be possible to prepare all the solutions employed in hypodermic medication: morphine, which suppresses pain, caffeine, which excites a weak heart, ergotine, which arrests hemorrhages, cocaine, which renders the skin insensible locally and permits of performing simple surgical operations, ether, which excites the nervous system, quinine, which reduces fever, etc.

A physician carrying some of these tubes about with him may immediately deal with the most pressing contingencies of his practice. The tubes are preserved in a zinc box, which is capable of holding a large quantity of them (Fig. 2).

The syringe, which is wholly nickel-plated, does not exceed the ordinary hypodermic one in volume (Fig. 3). It is composed of two parts: the one that forms a cover is an alcohol lamp, while the other is a box provided with feet that fold up under the bottom and containing, upon a special support, the syringe and the needles, B (Fig. 3). Without aid and without having need of anything else but a large glass of filtered water, one can effect the sterilization of the syringe in a few instants. When it is desired to use it, it is taken from the box along with the support. In order to fill the syringe with water, which is indispensable, it is necessary in the first place to pull out the piston rod to the end of its travel, and then to plunge the entire syringe into a glass of filtered water and then to push the rod in. Through this maneuver the water enters

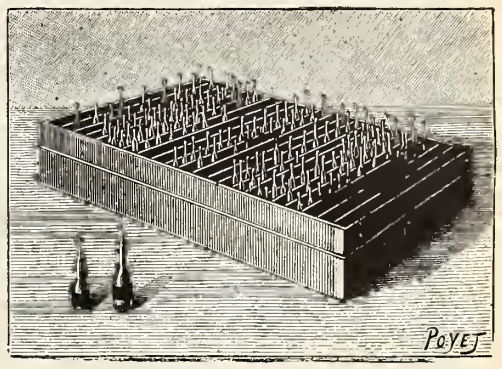



FIG. 2.—ZINC BOX CONTAINING THE TUBES.

the entire body of the cylinder above the piston in infiltering from above on every side of the rod.

The latter is finally drawn out a few millimeters, in order to suck in a little water beneath the piston. The syringe thus prepared is placed upon the support and the latter is put into the box, which is large enough to hold the syringe with its rod slightly extended. The feet are unfolded and enough filtered water is poured into the box to cover the syringe and needles. The small lamp, having been lighted, is placed between the feet (Fig. 3) In three minutes ebullition takes place, and is kept up for two minutes. It remains to take out the syringe, to expel the water that it contains, and to fill it by means of a sterilized tube.

Thus, then, through the use of this method, in which everything is sterilized—the syringe, the needles, and the solution—the invalid will, without fear, be able to receive the puncture which always relieves, often cures,

FIG. 4.—STERILIZED TUBES, NATURAL SIZE.

and sometimes, even, may perform miracles in desperate cases.—*La Nature.*

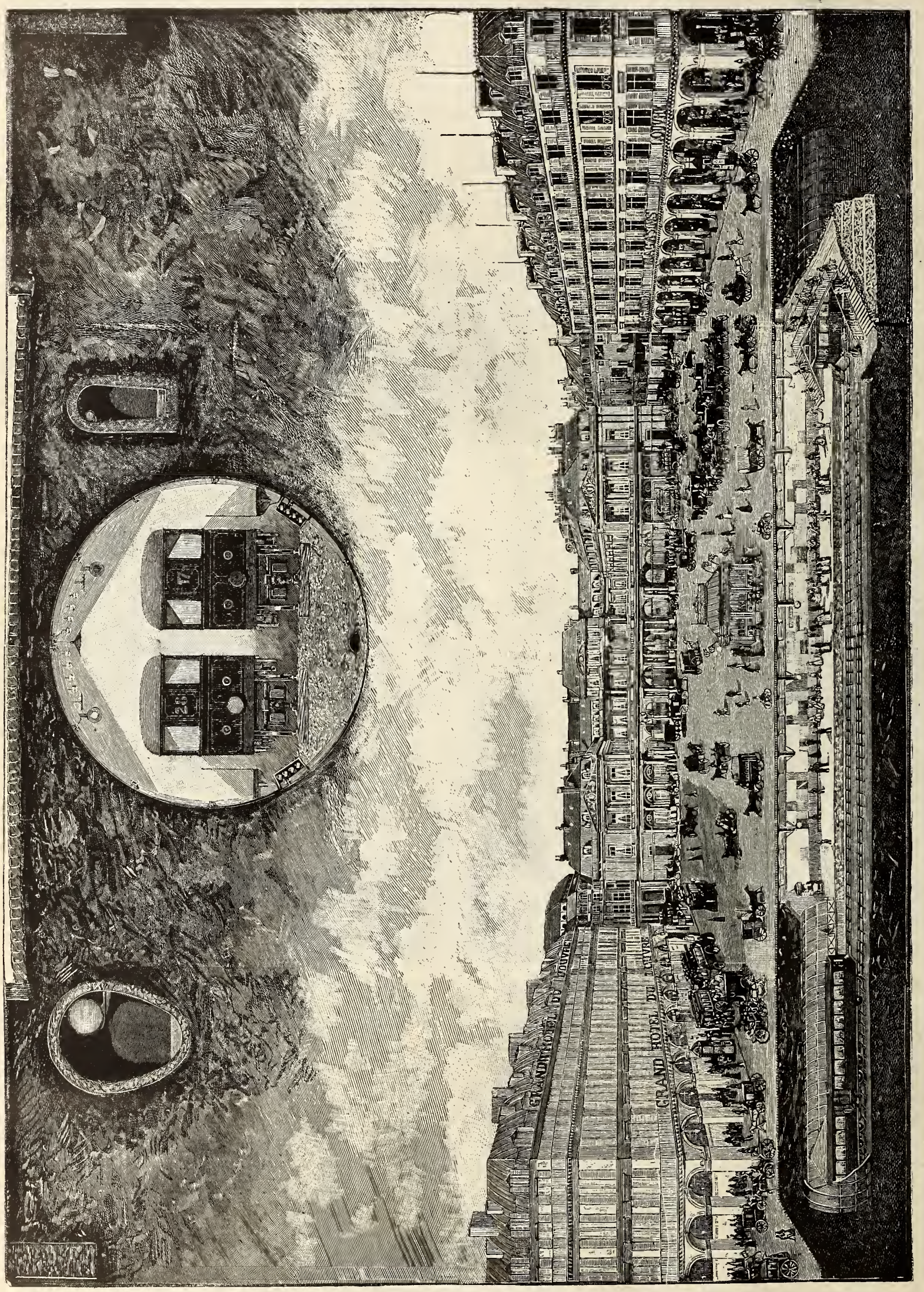
## WATER VIBRIOS.

ACCORDING to the studies of Sanarelli, the idea of the morphological unity of the cholera bacillus must be abandoned, since there exist different varieties of vibriones morphologically distinct, which are capable of producing in man and in the lower animals one and the same type of cholera, clinically identical. Koch's bacteriological diagnosis of cholera, as recently established, agrees neither with the idea of a limited monomorphism nor with the assumption of a polymorphism of the vibriones, since in every impure water we may find pathogenous microbia which possess quite the same characters as the specific exotic vibriones. In addition to the morbific forms originating in the water, which exactly resemble those from the bowel, there are found in water a number of non-pathogenous microbia which approach the former very closely, so that they may be regarded as varieties capable, under certain circumstances, of resuming their former (?) malignant properties. This constant occurrence of pathogenic microbia in all sewage is a proof of the great importance of the pollution of water for the origin and the spread of cholera. The water vibrios and those of cholera dejections are in every respect very closely allied, which points to a common origin. Virulent water vibriones do not long retain their malignant character; they gradually disappear along with the other characteristic properties of the vibriones, such as the formation of nitrites and of indol.—*Annales de l'Inst. Pasteur and Chemiker Zeitung.*

## THE TUBULAR RAILWAY OF PARIS.

SINCE the twenty years that it has been upon the carpet, the question of an elevated railway, ever pending and never solved, has periodically aroused in the public a ray of hope, soon followed by a new deception. The certainty that, in default of an elevated railway, we are going to have a subterranean tubular tramway line between Bois de Vincennes and Bois de Boulogne has recently been received with joy.

The project for the establishment of it, submitted by Mr. Berlier, its author, to the city of Paris as long ago as the first of September, 1887, was successively examined by the Administration and the Municipal Council. Postponed in 1888 for further study, it was resumed three years later, and on the 25th of July, 1891, the council, upon the report of Mr. Sauton, decided to submit it to an inquiry as to its public utility. Such inquiry was entirely favorable, despite a few interested objections of the omnibus company and of a competitor, the author of a rival project.




THE TUBULAR RAILWAY OF PARIS.

1. Section of the tunnel under Rue Saint Antoine. 2. View of the Palais Royal station.

The projected direction line will burrow the subsoil of the following public thoroughfares: driveway of Vincennes, Place de la Nation, Boulevard Diderot, Rue de Lyon, Place de la Bastille, Rues Saint Antoine and de Rivoli, Place de la Concorde, Avenue des Champs Elysées, Place de l'Etoile, Avenues Victor Hugo and Bugeaud, ending at Boulevard Flandrin. This line will be one of 6·6 miles.

What particularizes the Berlier project is, in the first place, the construction of the railway by pushing it forward underground without opening wide trenches in the public thoroughfares, the use of metal for lining the sides of the tunnel, and, finally, the exclusive use of electricity for the propulsion of the vehicles and the internal lighting of the tunnel and stations.

At the time of the deposit of the project, these innovations were earnestly discussed. Was it possible, in fact, to establish underground, that is to say, without an opening upon the public thoroughfare, a metallic tube, 19 feet in diameter, designed for the running of trains therein, and would not the execution present insurmountable difficulties?

The experiment has now been made, and the delegation of the Municipal Council sent to London three

years ago saw two three-and-a-half-mile subterranean lines established according to these principles and which were operating in the most satisfactory manner.

Although the tunnel can be established throughout its entire length by subterraneous excavation, the same is not the case with the stations and the junction parts in masonry. Here another method of work will be employed, but one that will not interrupt travel during the execution of it. To this effect, the arrangements made by the service of public thoroughfares at the time of the reconstruction of the street pavements have suggested themselves.

At each station a foot bridge connecting the platforms of the outgoing and incoming trains will be installed at the upper part of the tunnel, so as to have but a single stairway debouching upon the thoroughfare. It may be considered that the construction of such stairways will not be accompanied with any more inconvenience to the public than that of any sewer branch whatever. Such inconvenience will be still less if these stairways are placed in lands adjoining the line where too great a travel or insufficiently wide sidewalks would not permit the grantee to establish a structure upon the street. The Commission of Inquiry of the Municipal Council pronounced itself formally against any building upon the public way in the center of Paris, between Place de la Concorde and Place de la Bastille. The same would not be the case upon the wide sidewalks, avenues or places, such as Place Victor Hugo and Avenue des Champs Elysées. It is not a question, however, in this case, of establishing true offices in which the employes and the public would be called upon to remain momentarily. The kiosks constructed will be simply designed to close the passages and the stairways that allow the public to reach the subterranean railway.

The method of construction that we have indicated will be applied to all the stations save that of the Bastille, which will be an open one constructed upon the basin of the arsenal. This station will have a monumental character that will contribute to the aspect of the place. Conformably to the wish long ago expressed by the service of public thoroughfares, the place will be widened at the exit of Rue de Lyon. To this effect the basin will be covered throughout its extent, and the station will be established at twenty feet to the rear of the present parapet, where are now located the termini of the Porte Rappe and Montparnasse tramway lines.

It remains for us to examine the use and the role of electric propulsion. The efficacy of this is not discussed. It is demonstrated to-day by the City and South London Electric Railway, which was visited by the delegation of the Municipal Council during its stay in London, and which carries thousands of passengers daily. It will be seen that in this innovation, as well as in several others, Paris has been distanced by English capital, with which the results obtained are of a nature to reassure Parisians, and especially the ladies, who might experience some mistrust in regard to the new mode of locomotion.

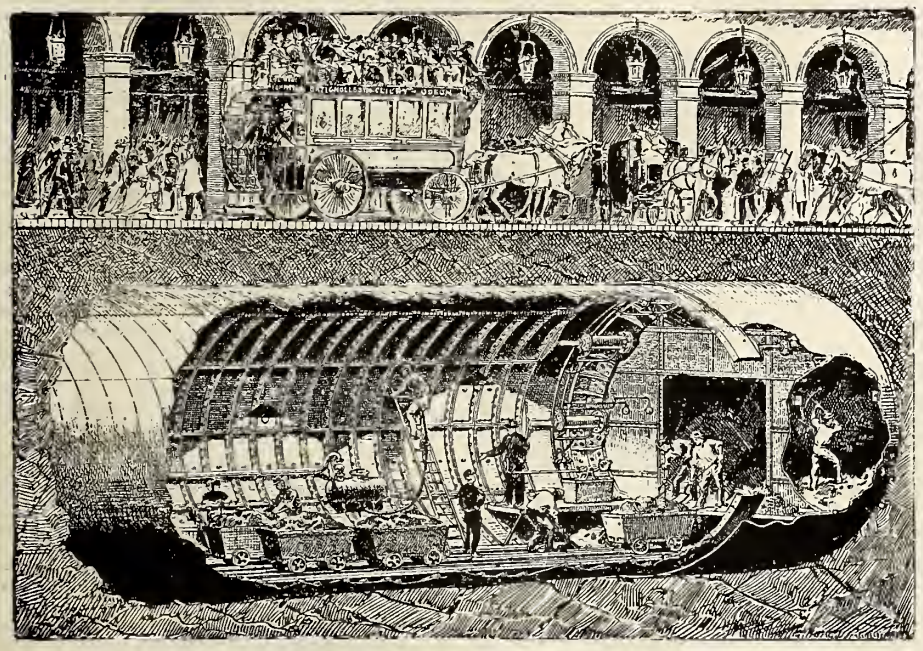
The following, in a few words, is the mechanism of the electric propulsion employed by the Berlier system. Between the rails there runs a conductor of rectangular section isolated from the ties by blocks of glass. This conductor is supplied by feeders that start from the main copper cables, which are insulated in a rubber sheath inclosed in lead and connected with the sides of the dynamos of the electric plant. The rails form the return conductor.

A few words as to the manner in which the author of the project intends to assure the service of the line, and as to the peculiar arrangements of the vehicles, will interest our readers.

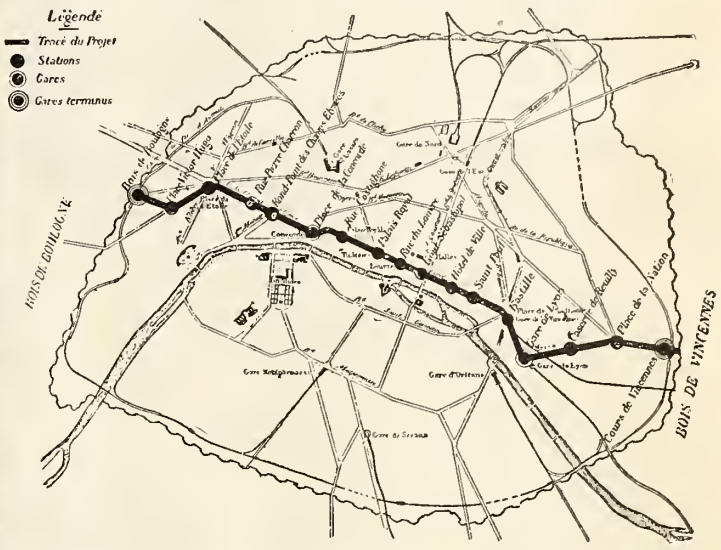
Each train will consist of one, two, three or four cars each, with a seating capacity for fifty-two passengers. The speed will be about twelve miles an hour. The total duration of a complete trip, including stoppages at the stations, will be 37 minutes and 33 seconds. At each of the 15 stations a stop of 20 seconds will be made, say, in all, a stop of 5 minutes. The trains will, therefore, make the entire trip of 6·6 miles in 32 minutes and 33 seconds, exclusive of stoppages. The cars will be entered at the sides, as in railway cars. The floor of the compartments will be on a level with the station platforms. Ordinarily, the trains will follow each other at two minutes interval upon a portion of the line (from Place de la Concorde to the Lyons station) and at four minutes upon all the rest. Upon days of fetes, races and reviews, in which the influx of passengers is greater, the number of the trains will be easily increased. The Berlier project presents two improvements upon the London Subway. In the first place, instead of being established under ballast, which produces a deafening noise when the cars are under way, the two tracks of 3·28 foot gauge will rest upon wooden ties embedded in ballast in order to deaden the noise. In the second place, the ventilation of the tunnel will be better assured. As electric propulsion disengages neither gas nor smoke, no attention whatever has been paid in London to ventilation, and no special measure has been taken in regard to it. Here, on the contrary, the tunnel will be ventilated by means of draught chimneys, starting from the summit of the tube and connecting with the interior of the structures placed upon the sidewalks. Let us now examine the question of fare, which especially interests the population of Paris. Mr. Berlier at the outset requested that the price of seats should be fixed at 6 cents for the first class and 3 for the second, but in the train of the observations of the lamented Mr. Alphand, he accepted the single price of 4 cents for a single class, whatever be the distance to be traveled. The third commission of the Municipal Council, by a vote of 6 to 5, did not, despite the opinion of the reporter, think it its duty to agree to these latter propositions, and pronounced itself in favor of two classes.

Let us hope that the Municipal Council will not persist in such a view, since, to point out but a single advantage of one fare, the public would find itself freed from the irksome obligation of standing in a line at the first wicket in order to get a ticket to be punched by an employe before entering the car, and, finally, on arriving at his destination, of presenting this ticket again to a third employe.

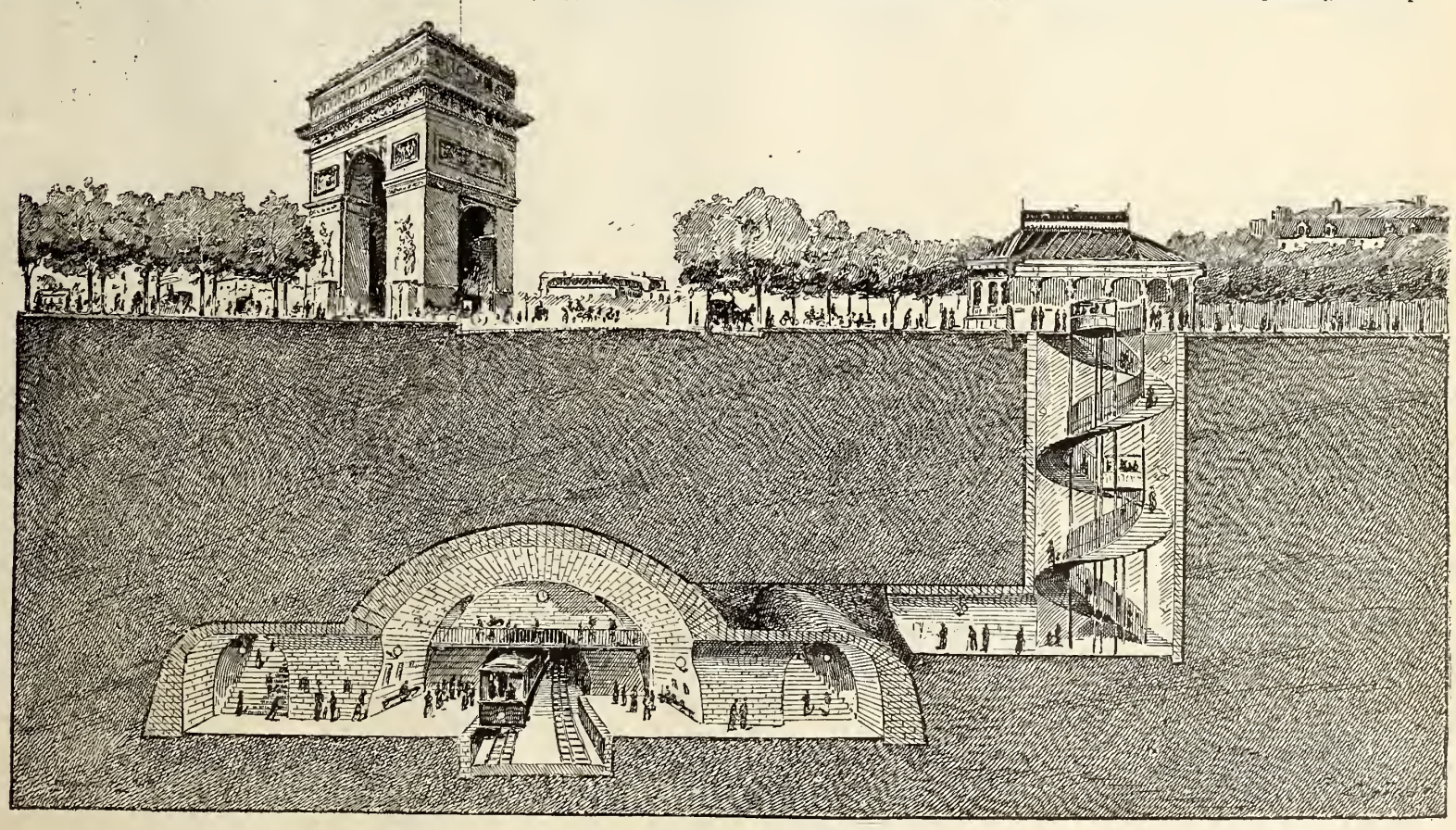
It would suffice for the passenger to deposit his fare



EXCAVATION OF THE TUNNEL UNDER RUE DE RIVOLI.




DIRECTION LINE OF THE TUBULAR RAILWAY BETWEEN BOIS DE BOULOGNE AND BOIS DE VINCENNES.



PLACE DE L'ETOILE STATION.

## THE TUBULAR RAILWAY OF PARIS.

in the orifice of a turnstile, which would mechanically control his right of access to one of the cars of the first train to start. The loss of time thus avoided would be an advantage so much the greater in that the trains having to succeed each other at two minutes' interval, the least retardation would be reflected upon the entire line.

Such, in its broad lines, is the economy of the tubular railway, whose realization is awaited by the Parisians with so much impatience. According to Mr. Berlier, the road will be finished and in operation during the course of the year 1898.—*Le Monde Illustré.*

## IMPROVED STEAM TURBINES.

THE steam turbine seems to be attracting very considerable attention at present, judging from the numerous patents being applied for, chiefly by electrical engineers.

The Parsons turbine is an acknowledged success and is doing good work, and we recently described the De Laval turbine, which also seems to succeed. The Morton steam turbine was the subject of a paper read by Mr. Morton before the Glasgow Society of Engineers and Shipbuilders. It is based on the reaction principle, if we accept the author's statement, but the fixed curved blades look very like guide blades, and according to Rankine a reaction turbine is a turbine without guide blades. We rather think, if the nozzles were fixed, and these curved blades allowed to revolve, the results might be better. The author admits that the action of the jets against the blades is equal, and opposite to, the reaction in the nozzles. If that is so, why not fix the nozzles and revolve the blades, and thereby make a simpler engine without all the packing rings and making the lighter part the moving part? However that may be, this turbine is a valuable contribution to the class, and we give the following extracts from the paper read upon it by the inventor himself, with sections of the turbine.

We may say that many years ago the steam turbine question was well thrashed out by engineers, and the patent records contain scores of ideas on the subject, some worked out and some only proposals. The paper is devoted chiefly to a description of some improvements recently made on the oldest engine we have any account of in history, viz., the revolving eolipile of the ancients, described by Hero, of Alexandria, in the second century B. C.

This improved engine, and dynamos to suit, were made, and the drawings, Fig. 1 and 2, represent it. Fig. 1 is an end section, showing on the left of the vertical central line one-half of the first or outward flow wheel, and on the right of the same line one-half of the inward flow wheel.

The casing, A, of this engine has only one simple compartment, Fig. 2, the casing being one casting, with two end covers bolted there o, inclosing two distinct and separate wheels. The first wheel, B, has three rings, 1, 2, and 3, of outward flow nozzles of different diameters. The first or smallest ring is 9½ inches, the second 12¼ inches, and the third 15 inches diameter, thus forming annular spaces between the rings. The second wheel, B, has two rings of inward flow nozzles, 4 and 5. The larger ring is 15 inches, and the second, or inner, 12¼ inches, diameter, thus forming an annular space between the two rings, into which spaces the curved projections, F and F', are fitted. Both wheels are mounted on the same shaft, D, and inclosed in a single compartment casing, A. The higher pressure steam enters the first wheel, B, by an annular opening around the shaft, D, as shown by the arrows (Fig. 2), and travels outward through the first ring of nozzles into the first annular space between the first and second rings, and flows out through the nozzles of the second ring into the second annular space, and from thence outward through the third ring of nozzles into the casing, A, which is common to both wheels.

The steam returns from the casing, A, flowing inward, first through the larger ring of nozzles, 4, into the annular space between the rings, and in through the second ring of nozzles, 5, toward the center of the inward flow wheel, $B_1$, thence through the exhaust annular opening around the shaft, and by the branch to the condenser.

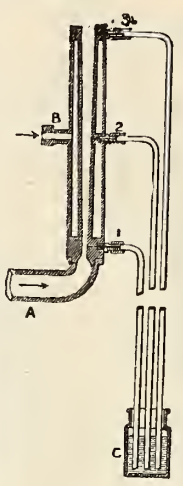


FIG. 5.

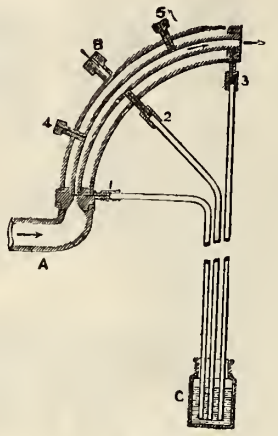


FIG. 6

At each ring of nozzles the combined area of these openings increases as the steam becomes reduced in pressure. The first ring of the series has eight, $\frac{1}{8\frac{1}{2}}$ inch by ½ inch, and the last ring ten curved nozzles, $\frac{1}{8}$ inch by 1 inch, and there are only five stages of expansion in this engine. The steam issuing from the curved nozzles in a tangential direction tends to circulate in a contrary direction to that in which the wheels may be revolving, to prevent which a series of curved projections, E, are cast or fixed on the interior of the casing, A, for the outward flow current, and another series, F, are cast on or fixed to centrally fixed disks, H, in the interior of both the outward and inward flow wheels, so as to arrest the outward and inward flow currents. These projections are more clearly shown by the enlarged sections, Figs. 3 and 4.

Fig. 3 is an enlarged section of a segment of the casing, A, inclosing a segment of the outward flow side of the wheel. The curved projections, E, are shown cast on the interior of the casing, A, to prevent circulation therein, and Fig. 4 is a similar segment of the casing, A, inclosing and showing in section a segment of the inward flow side of the wheel, B. The curved projections, F, in the interior of the inward flow side are cast or fixed on a central stationary disk, H, supported by its central trunnion passing out through the wheel, and fixed in the partitions.

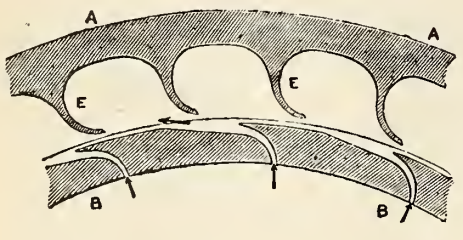


FIG. 3.

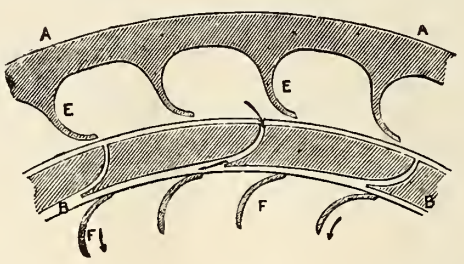


FIG. 4.

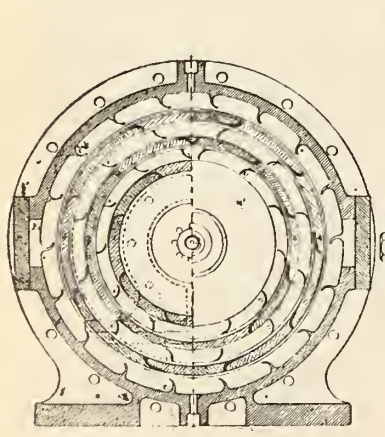


FIG. 1.

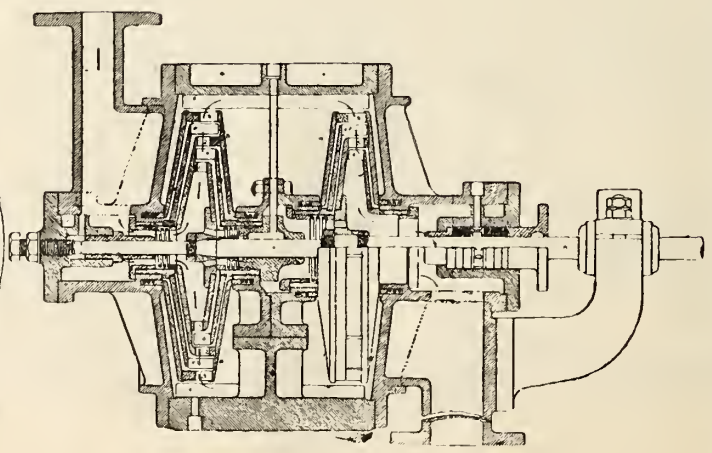


FIG 2

IMPROVED STEAM TURBINES.

To describe the numerous experiments, with different forms of nozzles, before the form shown on the drawings was adopted, would require a paper on that subject alone; but the two experimental apparatus shown by Figs. 5 and 6 are so important to this paper that they cannot well be left out. Fig. 5 is a full size section of an apparatus constructed with a central cylindrical tube $\frac{5}{16}$ of an inch wide at the narrowest part, or throat, tapering to $\frac{5}{8}$ of an inch at the mouth. The tube is 10 inches long, and has three small branches, 1, 2, and 3, communicating, by very small holes, with the interior of the tapered tube. To these branches, 1, 2, and 3, three bent glass tubes are coupled by short pieces of India rubber tube, and these glass tubes reach down to near the bottom of a dish of mercury, C.

The apparatus is bolted on to a branch steam pipe, A, with the throat end next the supply steam branch, all as shown by Fig. 5, ready for experiment. On opening the stop valve so as to admit steam to the supply branch, A, it flows through the throat of the apparatus, and is freely delivered into the atmosphere at the mouth or wider end, and the effect is shown by the mercury rising in the glass tubes connected with the branches, 1, 2, and 3. The mercury in No. 1 rises highest, that in No. 2 next, and that in No. 3 scarcely any, showing that a partial vacuum is maintained throughout the whole length of the tapered discharge tube. In case the naked tube should in any way affect the experiment, it was inclosed within a parallel brass tube and soldered, so as to leave a free space all round.

Steam was admitted into this annular space by the branch, B, so that the central tapered tube was incased with steam of a higher temperature than that passing through it; but on again performing the experiment, practically the same result was obtained, viz., a partial vacuum throughout the whole interior of the tapered tube, the vacuum being greatest near the throat.

Another experimental apparatus (Fig. 6) was made in form of a bent tube, tapering from $\frac{1}{16}$ inch by ¾ inch at the throat to $\frac{7}{16}$ inch by ¾ inch at the mouth, incased in a larger tube, and soldered steam tight. The branches, 1, 2, and 3, communicate with the mercury dish, C, as in the previously described experiment, and those branches, 4 and 5, with pressure gauges. The acting steam is admitted by the branch, A, and the incased steam by the branch, B.

On performing the experiment, it was found that a partial vacuum was maintained all along the lower or convex side, and a partial pressure all along the upper or concave side of the incased bent tube; there is, therefore, a partial pressure on the concave side and a partial vacuum on the convex side of a tapering bent tube at the same instant of time when high pressure steam passes freely through it into the atmosphere, and this is the form of nozzle which has been adopted, and shown more clearly on the enlarged scale drawing, Figs. 3 and 4.

It would seem from those experiments that steam issuing freely from an orifice, without admixture of air or other vapor by induction, expands very little, if any, laterally when free to expand on end, thus behaving very similar to that of liquids—such as water under the same circumstances.

In concluding this paper, a few remarks as to the efficiency and uses of this reaction engine would be useful. The engine, coupled direct with the dynamo (Figs. 1 and 2), has only two compound wheels, and when both were in place, with a given weight of steam, this engine developed 11·0 electric or brake horse power, and when the low pressure wheel was removed, and the high pressure wheel alone in place, the duty, with the same weight of steam, fell off to 6·5 B.H.P.; and with the high pressure wheel removed, and the low pressure wheel replaced, 4·5 B.H.P. was given, thus agreeing with the experiment when both wheels were in place, 6·5+4·5=11·0 B.H.P.

In March last, Dr. Archibald Barr and Mr. Henry A. Mavor, of the firm of Messrs. Mavor & Coulson, electrical engineers, made a joint series of experiments on the engine represented by Figs. 1 and 2, and from their report the duty—with 78 lb. per square inch, above atmosphere, initial steam, 20 inches vacuum, the engine developing 10·16 B.H.P.—required 87 lb. of steam per B.H.P. per hour, with feed water at the low temperature of 40·3° F.—*The Electrical Review.*

## LUBRICATION.

AT the February monthly meeting of the Birmingham Association of Mechanical Engineers a paper was read by Mr. H. Rallings on "Lubrication." The lecturer first called attention to friction, that familiar resisting force which always acts to prevent or retard the relative motion of one particle or body in forced contact with another. There are three kinds: sliding, rolling friction acting between solids, and fluid friction acting between particles of liquids. Friction, whatever kind considered and whatever its cause, always results in the conversion of an amount of energy measured by the work of friction into heat. This production of heat occurs in every case in proportion of one British thermal unit for each 772 foot pounds of work absorbed by friction. The amount of heat produced may therefore be calculated by dividing the total work of friction for any given case by this "mechanical equivalent of heat." Thus one horse power expended in friction results in the conversion of work or energy into British thermal units per minute. For example,

$$\frac{33{,}000 \text{ foot pounds}}{772} = 43 \text{ B. T. U.}$$

The friction of solids was dwelt upon, and attention was called to the necessity of smoothness of bearing surfaces, the proper space to leave between shaft and bearing, just to allow of proper flow of lubricant, the length of journals in proportion to their diameters, and several hints how to convey the lubricant to reduce the friction. He next dwelt upon the lubrication

best suited for the surfaces above referred to, taking as his model machine "man," noting that all joints of the body were supplied with an oily fluid, "synovia." The glands being supplied with blood vessels, and the blood passing through them, they select properties and convert it into this oil for lubrication; the greater the exertion or hard work on these joints, the greater the flow of oil. The viscosity of the lubricant played an important part. If the load forcing in contact the surfaces were not kept apart by a lubricant of right viscosity, a partial rubbing of surfaces is the consequence, causing a heated bearing, which is oftentimes believed to be due to neglect or other causes. If the body of the lubricant is in excess of the force working on the surfaces, the friction is practically *nil*. The lubricants are of three classes—solids, semi-solids and liquids. He saw no necessity to call their attention to solid lubricants, or to the semi solid lubricant, although in many cases doing good work when well attended, but particularly called the attention to the liquid lubricant. He said the liquid should have at least five important points: (1) Enough body or viscosity to keep substances between which it is interposed from coming in contact under maximum pressure; (2) the greatest fluidity consistent with preceding requirements, *i. e.*, the least fluid friction; (3) the maximum capacity for receiving, transmitting and carrying away heat; (4) the entire absence of acid or other properties liable to injure the material with which they may be brought in contact; (5) a high temperature of evaporization and of decomposition.

Oils should not be liable to decomposition by heat or wear; the quality of the oil is usually of more importance than the quantity. Sperm oil is one of the best known lubricants, but its high price precludes its use. Other oils are cheaper, but have less lubricating power; others are good reducers of friction, but do not wear well. Castor oil is one of these; others gum so seriously that they cannot be used. Some cannot be used at a low temperature, because they congeal; and others cannot be used to lubricate steam cylinders because they decompose. He advised every user of lubricants to resort to some method of identification of the material by giving some method of testing it and ascertaining whether under the conditions in his practice it will serve his purpose.

The best lubricants are the following for usual conditions met with in practice, under very great pressure with slow speed: Graphite, soapstone, tallow and other greases. Under heavy pressure and high speed: Sperm oil, castor oil and heavy mineral oils. Under light pressures and high speed: Sperm, refined petroleum, olive, rape and cotton seed. Ordinary machines, lard oil, heavy mineral and other vegetable oils. Steam cylinders, heavy mineral oil. Having called attention to the lubricant best suited for bearings usually to be met with in engineering, attention was next called to the necessity of special lubricants for cylinders, especially under the high pressure of steam now in use and the heat that severely tries the oils used in gas engine cylinders. The lubricant specially set forward as best suited for such was that treated by the system of superheated steam to 1,400 Fah. The oils treated by this heat are mineral oils, sometimes called hydrocarbon oils, the process driving off the volatile oils; it is then repeatedly filtered through charcoal, etc., until all solids are removed without the original structure of the oil being in any way damaged.

This class of oil, although dearer than the black oils in use, is much cheaper in the end, when it has been proved again and again that by the sight-feed cylinder lubricators that are now so perfect that as few as two spots per minute will be ample to lubricate an engine of 200 horse power. Having treated all points in cylinder lubrication, he turned his attention to some of the ways the lubricant was applied to ordinary bearings. The wick feed was shown as having good points, but in the hands of careless attendants the wick could be fitted too tight and prevent the supplying of oil from the reservoir. The needle lubricator has great advantage over the other, because it was automatic and was one that could be seen by any one, whether full or empty, preventing guesswork; but these also in the hands of careless men could remain inactive, if the body of the oil was greater than the space allowed for its steady flow. A change of oil causes these to require a little adjustment.

The next best is the sight feed spotting lubricator, where the oil, whether thick or thin, can be spotted at any desired speed; the oil can be caught and set aside for other purposes. The best form is the bearing known as "Mohler's" self-lubricating; this is also known by the name of "patent bearing." It has a well of oil, and the collar in the revolving shaft lifts the oil by capillary attraction, and when at the top a spreader in the cap spreads it over the whole length of the bearing, and will do this for one month with one charge of oil, so is always in action and requires no attention day by day as others do. Some bearings, especially large main bearings of engines and main shafts, where oil is pumped in a continuous stream with small revolving pumps, this is exceedingly good, but only applicable to heavy work. He next devoted some time to semi-fluids for solid oils, also how they were chiefly used, the special forms of lubricators to use this grease, but was particular to point out that, although in some instances these greases were doing good service, yet there was not the automatic and reliable feed as there was with liquid oils. He most strongly urged the members that had under their charge large plants requiring lubricating to read Prof. Thurston's work, "Friction and Lost Work;" to this valuable work he is indebted for much help on lubrication. He quotes that Prof. Woodbury reports an instance out of several where a gain of power of 33 per cent. was effected by a change of grease for a light oil, the loss in cost of lubricant being comparatively unimportant.

Attention was called to reserving all used oils and filtering them, and using over and over again. Also to a simple test to prove the good and bad oils. In conclusion, he trusted that what had been placed before them would assist them to decide on the lubricant, whether for heavy or light work, and that it be the best consistent with price, and to give the preference to oils that will not char or gum, and to be sure to see oil tested from bulk is same as sample supplied, and that for cylinders to have the best mineral oil money can procure, especially as it is for so vital a part, to decide upon good lubrications such that can be seen in action, then something will be done to assist in saving coal and labor and satisfy yourself that you have given special attention to one important matter, "Lubrication."

## WASTE ENERGY.

By GEORGE HILL, M. Am. Soc. M.E.

THE amount of energy which is constantly being given off without doing any measurable, useful work may justly be said to be far beyond all conception. Even if we limit the field to the so-called wastes which occur in one city, measuring simply those of which we have knowledge, the total expressed in figures would be something astonishing. But leaving broad generalizations, leaving the question of utilizing the heat of the sun's rays, or recovering useful work from the potential energy stored up by the tons of water that the fleecy clouds carry through the air, or in the tides ever ebbing and flowing, or in the waves of the ocean, could we harness any of them, let us see what it costs to use present appliances under ordinary conditions.

In order to be able to express results in intelligible form, let us assume the case of a fifteen story office building, 50 by 100 feet, standing on the corner of a street, the stories being all above the street level, and the basement being devoted to the power plant. The entire building and its plant would be designed in accordance with the best modern practice, with electric light, hydraulic elevators, exhaust steam for heating, etc.

The mechanical work required to be performed in a building may be said in a general way to be lighting and heating it, and to elevate its occupants to the points to which they desire to go, and also to lower them from these points. The amount of work actually required to be performed is, first, an expenditure of a certain number of foot pounds of work for heating, which may be most readily expressed in tons of coal. We would have to make good losses by radiation through walls, windows, floors, roofs, etc., and would have to warm the entering air required for ventilation. For the purpose of the present case it may be assumed that all this would require, say, 85 tons of coal a year, or 2,125,000,000 heat units.

Taking the year round, there would be required for the lighting of such a building as is here in mind about 1,000,000 lamp hours, this assumption being based on a lighting capacity of each lamp equivalent to 16 candles. This converted into coal, on the assumption that each pound contains 12,500 heat units, and that one candle power is equivalent to 0·0688 heat unit per hour for 100 per cent. efficiency, based on data obtained from the arc light, gives the number of tons as 0·044. For elevating the requirements are, of course, zero, since if we had an elevator of perfect efficiency, and a method of storage of perfect efficiency, we could, as soon as we had stored up enough energy to do one day's work, go on forever, the energy expended in elevating people being stored up again when they are lowered, and the energy required to start the car at the landings being made up by the energy given out when it was stopped. From this it will be seen that if we had machines of perfect efficiency, we should be able to perform all of the mechanical services of one of our large buildings with an expenditure of 85·044 tons of coal.

To determine what the wastes would be in this building we must convert the potential energy stored up in the coal into useful work. Various methods have been proposed of accomplishing this, but the limitations imposed by cost, convenience of manipulation, usage, etc., all point toward the steam engine. I would not be considered as in any way decrying the vast amount of human ingenuity which has been expended thereon, but I cannot but feel that it is very unfortunate that our development should have taken place in utilizing the expansive force of steam rather than in some other way, as will be hereafter noted. In the first place, the present use of coal involves a loss at the outset, due to waste in the mine, waste in its preparation for the market, waste in transmission and waste in useless combustion, these combined wastes amounting to probably two pounds of coal for each pound used.

Taking the steam engine in its most efficient form, we would have, where it is non-condensing, between the limits of 14·7 and 300 pounds pressure absolute, an efficiency of about 23·4 per cent., this being found by dividing the difference between the absolute initial and final temperatures due to the pressures assumed, by the absolute initial temperature. If we take the practical limits of 120 pounds of initial pressure and 5 pounds back pressure, we would have an efficiency of 15 per cent., which corresponds to a consumption of coal of 1·33 pounds per horse power per hour, and it is on this basis that we must calculate the generation of all power required for our electric lighting.

At the present state of efficiency of the art of electric lighting, we can, as a practical thing, obtain about twelve 16 candle power electric lamps for each horse power. This would make necessary the generation of 85,000 horse power hours annually. Should we attempt to gain so high an efficiency, as above noted, we should have to run the engines constantly, and therefore often very much underloaded, since the lighting duty varies constantly, both during each hour and during the day, with a consequent high friction loss. If, on the other hand, we adopt a proper subdivision of engine capacity, we should have a lower efficiency, so that it will be but fair to assume that, adding the inevitable losses in the piping, in the cylinder of a good engine, etc., we would have 170,000 horse power hours as the amount of work required to be performed, which means the annual consumption of at least 113·5 tons of coal. Subtracting the net number of tons heretofore given for lighting from the above, and also subtracting the 85 tons required for heating, leaves a net waste of 28·5 tons. It might be said that gas could be more effectually used as an illuminant than electricity, which might be true, were it not that with gas at any price that you please per thousand, 20 feet will give but 80 candles if burned as an illuminant, while the same number of feet will give 160 candles if burned in the cylinder of a gas engine used for driving an electric generator, as an average for everyday practice.

These facts are sufficiently discouraging, but the worst of all is yet to be faced. When we come to elevating we find, usually, the hydraulic machine employed. This machine is simply a hydraulic cylinder with a piston working in it, which carries on the end of its rod one or more multiplying sheaves, over which the hoisting rope passes. Water under pressure is admitted on one side of the piston only, to elevate the car, which, by gravity, discharges this water on its down trip. It will be seen, therefore, that the number of trips made per day determines the amount of water consumed, quite regardless of the amount of energy required. The elevator cars are sometimes made of 1,500 pounds capacity, and range from that to 2,500 pounds, and are counterweighted within about 500 pounds, so that we should have about 2,000 pounds as the load. If the car runs at a speed of 450 feet per minute, and runs but one-third of the time, it would have an average speed of 150 feet per minute, and since it elevates only one-half of the time, the average speed throughout the entire day would be equivalent to 75 feet per minute, and since, further, there are in an office day, roughly, 500 minutes, we would have a total travel of 37,500 feet. This, multiplied by four, for the number of cars, and 2,000 pounds for the load lifted, the amount of water required to fill the cylinder being always the same, regardless of the load, gives a total of 300,000,000 foot-pounds per day.

If we assume that the pumps which are employed convert the energy in the coal into work at about the rate of 25,000,000 foot-pounds per 100 pounds of coal, which is an efficiency of about 2·6 per cent., we would require, to do the work, an expenditure of 1,200 horse power each day, and since there are 293 office days, this would mean 175·8 tons which are a total waste. In addition to this, we have the knowledge that a plant, said to be economical, takes double this amount of coal under the same conditions. Our bill would now stand as follows:

| | | |
|---|---|---|
| Coal required at building | | 289·3 tons. |
| Coal wasted in mining, etc., to deliver this amount at the building | | 578·6 " |
| Total consumption of fuel | | 867·9 " |
| Useful work expended in tons: | | |
| Lighting | 0·044 | |
| Heating | 85·000 | 85·044 |
| Loss | | 782·856 |

It is highly probable that the average losses are double this, and in many cases treble. This is truly a state of affairs of which engineers cannot be proud. The water wheel has an efficiency of something like 90 per cent., while the best that man can do when he comes to convert the energy stored up in the coal to his own comfort is about 10 per cent.

These losses might perhaps be reduced in a variety of ways. We know, for example, that it is entirely feasible to obtain an efficiency with water wheels and generators of about 80 per cent., and we could convert the energy stored up in the electric current into heat with an efficiency of about 90 per cent., and into light with an efficiency of about 20 per cent.; or we could convert the coal at the mines into gas with an efficiency of about 80 per cent., which could be converted into energy with an efficiency of about 25 per cent.; the latter could, in turn, be converted into electricity with an efficiency of about 80 per cent., from which we could go on; or we might use gasoline, natural gas, or some other form of liquid fuel with an efficiency of about 25 per cent.

We might even pulverize the coal, and by mixing it with air produce an explosive compound, which introduced into the cylinder of an engine would give an efficiency of about 25 per cent., but all of these figures are far below those that we should attain. If, instead of steam, we had used some other form of expansive gas, we might have reached a somewhat higher efficiency still; but for all of them there is a more or less insurmountable obstacle presented by practical conditions.

We owe a great deal, beyond any doubt, to steam, but we have reached the point where we should be able to see that steam is not the panacea for all ills. Somewhere, lurking in some man's brain, there must be the rudiments of the idea that will enable us to convert effectually the stored-up energy in coal into the useful energy of the electric current. It is certain that we must come to this eventually. Take the requirements of our office building: Every man wants his office heated a little differently. No form of apparatus that can be devised that is practical will accomplish this. The electric current does it perfectly, but unfortunately it costs too much. The incandescent lamp is much the most efficient form of illumination which we at present possess for the lighting of small spaces.

Ten times more efficient is the arc lamp, but we have not yet progressed far enough on the road to subdivide it sufficiently to satisfactorily adapt it to domestic and office building lighting.

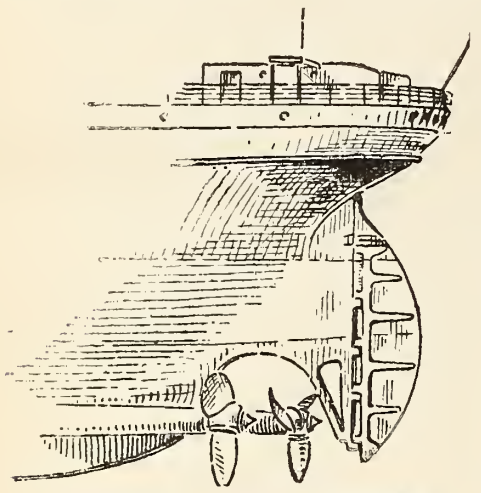
The electric elevator is now far more efficient than the hydraulic, requiring the expenditure of only about one-fourth of the number of foot-pounds and about one-tenth of the coal, but it is still inefficient in that we have no means of overcoming the waste caused by lowering people under the brakes when their weight exceeds that of the counterweight. In electricity, transmissions of over twenty miles have been made with a total efficiency of over 50 per cent., which is about ten times better than with steam, but it is much to be feared that this generation will have to be content with a comparatively wasteful form of converting energy, while fully realizing that just beyond its grasp lies one most perfect.

Do not let the fact that we are required to use the steam engine, and therefore, as its friends say, with a self-satisfied smirk, "We come back to it after all," blind us to the true condition of affairs, but rather let us hope that the day is fast approaching when it will take its true place as a scientific curiosity, illustrative of the unfortunate effects which follow from making a wrong start, the day that shall find us availing ourselves of the multitudinous forces provided on all sides by an all-wise Creator, with an efficiency equal to that already attained in the water-wheel.—*Cassier's Magazine.*

A MUSEUM now being erected at Leyden will be the largest in the world next to the British Museum. Within its walls space will be provided for eighty thousand stuffed birds.

## TWIN SCREW STEAMSHIP TORR HEAD.

THIS fine vessel, just built and engined by Messrs. Harland & Wolff, for the Ulster Steamship Company, is 452 ft. long between perpendiculars, 50 ft. beam and 35 ft. 4 in. deep; about 6,000 tons gross and 3,900 tons net register, and of a dead weight carrying capacity of 8,500 tons. She has been built under special survey, and is classed A1 at Lloyd's. She has been constructed, says the *Engineer*, under the three-decked rule, considerably in excess of Lloyd's requirements; is provided with a long forecastle, very long bridge house about amidships, extending from side to side and forming a complete protection to engine and boiler casings, with long poop aft. There are six hatchways with powerful steam winches by Wilson, of Liverpool, patent

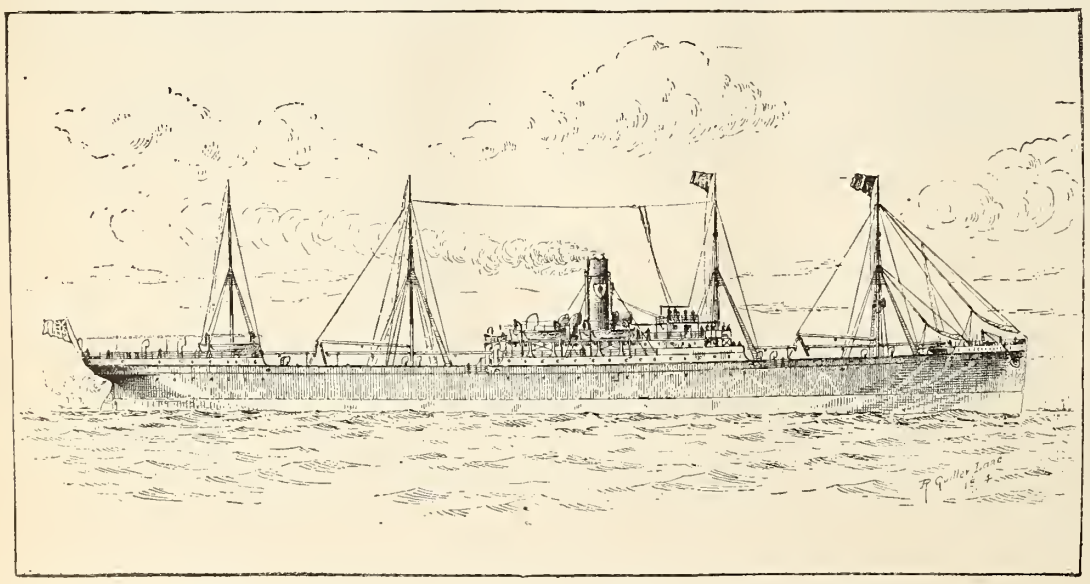


THE HANGING STERN FRAME.

steam windlass and capstan, and Pirrie & Wilson's patent spring tiller and direct steam steering gear. The Torr Head has been constructed on the cellular double bottom principle for water ballast, of which she can carry 1,400 tons, with large trimming tank aft, fitted for cargo. She has four steel pole masts, stayed on a novel plan, and stepped without any rake aft; these are for use as supports for her numerous derricks, which have full play when in port, there being no stays to interfere with their swing.

Saloon accommodation for the captain and a small number of passengers has been provided at the forward end of the bridge deck, with a teak chart house and wheel house above on the flying bridge. Engineers' and officers' quarters occupy the after end of the bridge deck. Petty officers are berthed in the forecastle and the crew in the poop. She has two heavy steel decks, and a bridge deck, covered with pine, and has a complete installation of electric light by Messrs. Holmes, Newcastle-on-Tyne.

The engines consist of two complete sets of the triple-expansion type, with all the latest improvements, indicating about 2,700 horse power at 180 lb. working pressure, steam being supplied by four steel boilers, two of them being double ended. She has a pair of screws of manganese bronze, placed extremely close together and overlapping. The stern framing is of a very peculiar form, patented by Sir E. Harland, as shown in the accompanying sketch. Shafting is of steel.



THE TWIN SCREW STEAMSHIP TORR HEAD.

## THE MAGNETARIUM.

MR. H. WILDE, F.R.S., lately exhibited and described his magnetarium before the Physical Society, London.

This consists of a hollow geographical globe wound all over the inner surface with insulated wire in planes parallel to the equator. Within this globe is a sphere wound with wire on its surface and having its axis inclined at 23½° to that of the outer pole. By means of epicyclic gearing the spheres can be made to rotate at slightly different rates. When electric currents of suitable strength are passed through the two windings, the magnetic condition of the earth can be imitated, both as regards distribution at any epoch and the secular variations. A better result was obtained by putting sheet iron over the land areas, and a still closer approximation by using thin iron over the water areas. A magnetic chart and tables giving the magnetic elements at various places for different epochs were shown. The author mentioned that recent observations by the United States Survey, at Ascension Island, and by Prof. Thorpe, in Senegambia, had confirmed results obtained by the magnetarium.

The president said he had tried the apparatus and found the Siberian oval closely imitated. The secular variations, at Greenwich, were also well shown. In South America the approximation was not so good.

In reply to a question by Mr. Blakesley, Mr. Wilde said the present position of the pole of the inner sphere was 84° W., 67° N.

## TELEGRAPHIC COMMUNICATION BY INDUCTION BY MEANS OF COILS.*

By Mr. CHARLES A. STEVENSON, B.Sc., F.R.S.E., M. Inst. C. E.

IN 1892 I suggested that communication could be established between ship and ship by means of coils, and as a trial of the system, on a large scale, has recently been made, with a view of establishing communication between North Unst lighthouse, situated on Muckle Flugga, and the mainland, a record of the trials may be of interest.

The induction of one spiral on another has been long known, but with a very strong battery current it has been found impossible to bridge a greater distance than 100 yards,† so that as a means of practical communication it was impossible. It has also long been known that communication could be established by means of parallel wires; and for many years this system has been under discussion, and only last month a series of elaborate experiments at Loch Ness has been made by Mr. Preece on this parallel wire system, on the most approved methods; but I trust to be able to show that the parallel wire system must give place to the method of communicating by coils.

It is evident that if two coils are placed so that their axes are coincident, their planes being parallel, or if they be placed so that their planes are in the same plane, they will be in good positions to expect electric currents sent in one to be apparent by induction in the other.

For a given diameter, and where the electrical energy is small and the number of turns small, the first position is best; but where the energy is great and the number of turns great, in fact, when it is wished to carry the induction to many times the diameter of the coils, then it will be found that it is better to let the two coils be in the same plane, as when the axes are coincident, and the coils a greater distance apart in comparison with the diameter, the difference of distance from one side of the coil, say top of primary coil to top and bottom of secondary, becomes almost a vanishing quantity; whereas, when the coils are lying on their side in the same plane, the difference of distance from back of primary to back of secondary, and from front of primary to front of secondary, does not fall off so fast, and consequently is more efficacious. Besides, it becomes impracticable to erect coils of large diameter with their planes vertical, but it is easy to lay them on their sides.

A number of experiments were made in the laboratory to discover the laws of the action of coils on each other, with the view of calculating the number of wires, the diameter of coils, the number of amperes, and the resistance of the coils that would be necessary to communicate with Muckle Flugga, and, after a careful investigation, it was evident the gap of 800 yards could, with certainty, be bridged by a current of one ampere with coils of nine turns of post office wire in each coil, the coils being 200 yards in diameter, and with two good telephones on the hearing coil.

Two coils, on telegraph poles and insulators, were erected at Murrayfield, one coil being on the farm of Damhead, and the other on the farm at Saughton, and as nearly as was possible on a similar scale, and the coils of similar shape to what was wished at Muckle Flugga. On erecting the coils, communication was found impossible, owing to the induction currents from the lines from Edinburgh to Glasgow, the messages in those lines being quite easily read, although the coils were entirely insulated and were not earthed. The phonopore which the North British Railway Company have on their lines kept up nearly a constant musical sound, which entirely prevented observations. On getting the phonopore stopped, it was found that 100 dry cells, with 1·2 ohms resistance each and 1·4 volts, gave good results, the observations being read with great ease in the secondary by means of two telephones. The cells were reduced in number down to fifteen, and messages could still easily be sent, the resistance of the primary being 24 ohms and the secondary no less than 260 ohms. If the circuit had been of good iron, with soldered joints and well earthed, the resistance should have been only 60 ohms. The induced current generated in the secondary would therefore be in the ratio of 480 to 210, or with this enormous resistance, allowing for the resistance in the two telephones in multiple, we got practically only half the current we would have got if the line had been a permanent, in place of a temporary, one.

A trial was made of the parallel wire system, and with 20 cells the sound was not heard, and with 100 cells it was heard by me as a mere scratch in comparison with the sound with the coil system with 15 cells. A trial was made with phonopore, and the coils worked with 10 cells with perfect ease, and a message was received with only 5 cells. Speech by means of Deckert's transmitter was just possible, but it is believed that if the hearing circuit had been of less resistance it would have been easy to hear.

It is difficult to understand how this system of coils, in opposition to the parallel wire system, has not been recognized as the best; for assume that, with the arrangement we had, we heard equally with 100 cells by both systems, both having the same base (200 yards), then, by simply doubling the number of turns of wire on the primary by putting on turns of thick wire, the effect would have been practically doubled, whereas by the parallel wire system there is nothing for it but to increase the battery power, which, *for practical working, becomes an impossibility.* The difficulty of the current is thus removed by using a number of turns of wire. It must always be borne in mind that the effect is the result of simply increasing the diameter, keeping current and resistance the same. The larger the diameter the better; in fact, with a given length of wire, a straight one is the best. But this is not practice. What is wanted is to get induction at a great distance from a certain given base with a small battery power, and the laboratory experiments and the trials in the field show that the way to overcome the difficulty of the current is by using a number of turns of wire. The secret of success is to apportion the resistance of primary and secondary, and the number of turns on each, to a practical battery power.

1. *Coil System.*—At 870 yards from center to center of coils, averaging each 200 yards diameter, with nine turns of wire, it was found that with a phonopore messages were sent with five dry cells, the resistance in primary being 30 ohms and the resistence of secondary 260 ohms, the current being 0·23 ampere, which, with nine turns, gives 2 ampere turns.

2. With a file as a make and break, it worked with 10 cells, giving 0·4 ampere or 3·6 ampere turns.

3. *Parallel Wire System.*—With a file as a make and break, and with parallel lines earthed, it was heard with 100 cells, giving 1·1 ampere.

The calculation of the diameter necessary to hear a given distance is simple, from the fact that the hearing distance is proportional to the square root of the diameter of one of the coils, or directly as the diameter of the two coils, so that with any given number of amperes and number of turns, to hear double the distance requires double the diameter of coils, and so on.

There is one fact which seems to have been cleared up by these trials which has even this month been a subject of discussion in London, and that is whether or not the parallel wire system is induction or conduction; and there is little room for doubt that to a large extent it is conduction, in fact that they act together; and it will depend how the ends are earthed, or, in short, what is the distance bridged in comparison to the breadth of base, which predominates. Where the wires are long in comparison with the distance bridged, conduction will be the main working factor; but when the base is small, and the distance bridged is large in comparison, induction will be the main factor, and the number of turns increases the effect.

The primary coil was insulated in the Murrayfield trials, as at Muckle Flugga it must be so, and the secondary was earthed, as is most convenient at Muckle Flugga. When the secondary was also made a complete insulated metallic circuit, with eight turns of wire, there seemed to be little difference in the result.

There is one other point to which reference must be made. Mr. Preece has been repeating the experiments brought before the Society on January 30, 1893, and he found, if rightly reported, that when the hearing wire was floating he got results, but when it was allowed to descend that no observations could be got. He attributes this to reflection from the surface of the water; this, however, is unlikely, as the reason that no sounds were then heard was that the major part of the wire lay on an equipotential line. Electro-magnetic waves enter or leave salt water practically unimpaired. On trial it was found, as stated in my paper read before this Society in January, 1893, that there was no practical difference in air or salt water to the propagation of electro-magnetic waves, the distance to which waves went, *i. e.*, the distance to which the currents could be heard, being immaterial whether the detector was sunk or in air.

It has been attempted to be shown that the coil system is not only theoretically but practically the best; and I trust that we will soon hear of the Admiralty, etc., experimenting with it, and ultimately putting it in practice. Meantime my brother has recommended the Commissioners of Northern Lighthouses to erect the coil system at Muckle Flugga, and the commissioners have approved, and I hope soon to hear of the erection of this novel system of communication at the most northern point of the British Isles, as well as on our warships, to assist in their maneuvering, by the establishment of instantaneous communication unaffected by wind or weather.

The application of the coil system to communication with light vessels is obvious, viz., to moor the vessel in the ordinary way, and lay out from the shore a cable, and circle the area over which the lightship moorings will permit her to travel, by a coil of the cable the required diameter, which will be twice the length of her chain cable. On board the vessel there will be another coil of a number of turns of thick wire.

Ten cells on the lightship and ten on the shore will be sufficient for the installation. The system erected at Kentish Knock and other light vessels is expensive in moorings, and is liable to derangement and requires special mooring, whereas by the coil system there can

* Paper read before the Royal Society of Edinburgh.

† *Journal* of the Society of Arts, vol. xlii, page 274.

be no derangement, and the vessel can be moored in the ordinary way. A call arrangement and telephones complete the installation.

## A HISTORY OF THE TELEPHONE.*

By W. CLYDE JONES.

IT was in 1819 that Oersted, a professor in the University of Copenhagen, while lecturing to his class, discovered that a magnetic needle, when held in the vicinity of a wire traversed by an electric current, was caused to assume a position at right angles to the axis of the wire. This experiment, though simple of performance, was a revelation to the scientific world, and confirmed the long-standing suspicion that electricity and magnetism were, in some mysterious manner, related. This was the spark that inflamed the minds of scientific men and led to the unraveling of the apparent mysteries of electro-magnetic action and the founding of the laws of electro-magnetism, to which we are in such a great measure indebted for the industrial development of the electrical arts.

Oersted had informed the world that there was a relation between electricity and magnetism, but it remained for Sturgeon, in 1825, to point out that there was not only a relation, but that electricity was even convertible into magnetism. He had encircled a bar of soft iron with a helix of wire and noted that upon the passage of an electric current through the helix the soft iron bar assumed the properties of a magnet. Here was the germ that was afterward developed into the telegraph and the telephone.

With the electro-magnet the minds of men naturally turned to the transmission of intelligence to a distance, and in the years immediately following Sturgeon's experiment we find the greatest scientific minds busily engaged with the problem. Neither the laws of the electro-magnet nor the laws governing the passage of a current along a wire, since so admirably expressed by Ohm, were at this time known, and the rapid falling away of the force of the current with increased distance led to the belief that an electro-magnetic telegraph would never be possible. Indeed, in 1829, Professor Barlow, of England, perhaps the foremost scientist of his day, after making an exhaustive study of the problem, published a demonstration, considered at the time conclusive, showing that it would be absolutely impossible to transmit intelligence to a distance by means of the electro-magnet.

But soon the dormant hope was again aroused by the publication of the researches of Joseph Henry, who had so thoroughly investigated the laws of the electro-magnet that no discoveries except of minor importance have resulted from later investigation; in fact, the electro-magnet as Henry knew it in 1830 is the electro-magnet as we know it to-day.

Ever since Sturgeon had converted electricity into magnetism the question ever uppermost in scientific minds was whether magnetism might not in turn be converted into electricity. In 1831 Henry and Faraday discovered that magnetism was, in fact, convertible into electricity, and was effected by varying the magnetic field threading a looped conductor. By this discovery, which has rendered illustrious the names of two great men, the world acquired information concerning the laws of electro-magnetism and the mutual convertibility of the two mysterious forces that immediately removed electrical science from the domain of the purely theoretical and experimental and gave it a place in the industrial world.

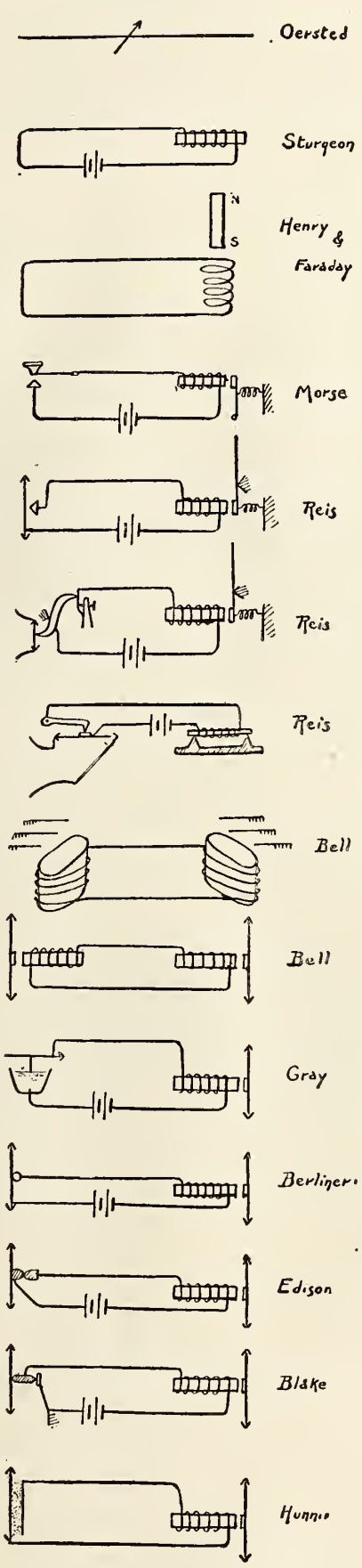
The time was now ripe for the development of the electric telegraph, and in the early 30's Samuel F. B. Morse had conceived the electric telegraph, which, toward the end of the decade, assumed practical form. With Sturgeon's electro-magnet placed at the distant end of the line, he closed an electric circuit by means of a key, thus causing the electro-magnet to attract its armature and convey to the operator at the distant end of the line the conventional signal.

Naturally, the operation of the Morse telegraph suggested the possibility of transmitting the voice itself to a distance, and, indeed, as early as 1854 we find Charles Boursel publishing to the world the possibility of speech transmission in words that have since become historic. He said: "I have asked myself if the spoken word itself could not be transmitted by electricity; in a word, if what was spoken in Vienna may not be heard in Paris. . . . Suppose that a man speaks near a movable disk sufficiently flexible to lose none of the vibrations of the voice; that this disk alternately makes and breaks the connection with a battery; you may have at a distance another disk which will simultaneously execute the same vibrations"

Boursel erroneously supposed that the voice could be transmitted by the opening and closing of the circuit, and thus outlined a path of research which science traveled for twenty years, until Bell, by his theory of electric undulations, removed it from the deeply worn rut. In 1861 Philip Reis, of Frankfort, Germany, apparently following the instruction of Boursel, constructed the first telephone, which comprised as a transmitter a diaphragm, adapted in its vibration to open and close an electric circuit. At the receiving station was placed an electro-magnet, which, by the successive current impulses sent over the line by the transmitter, caused the magnet to alternately attract and release its armature, to which was secured a thin plate, which in the vibration of the armature was moved back and forth, thus beating the air and setting in motion the air particles that conveyed to the ear the sense of sound.

By comparing the telephone of Reis with the telegraph of Morse, it will be observed that the transmitting instruments differ only in that Morse used a key actuated by the hand for opening and closing the circuit, while Reis provided a diaphragm which, for the sake of the analogy, we may consider a key adapted to be actuated not by the hand but by the vocal organs. Again, the only essential difference between the receiving instruments was that Reis had applied to the armature of the Morse instrument a thin plate for the purpose of setting the air particles in motion.

Reis, by opening and closing the circuit, was unable to transmit the complex current undulations upon which we know the transmission of articulate speech to depend, and was only able to transmit simple musical sounds. It has been contended by some that Reis actually transmitted articulate speech by means of his apparatus and understood the requisite of speech transmission, and, in fact, that speech has actually been transmitted by the Reis apparatus by causing the contacts of the transmitter to remain continuously in contact; but that Reis himself did not understand the necessity of an undulatory current and did not transmit speech may be inferred from the fact that in his later apparatus, which was by him considered an improvement upon the former, the construction was such that it is impossible to cause the contacts to remain continuously in contact. In the former instrument a pivoted lever was provided, one end bearing against the diaphragm and the other end against the end of a spring the circuit being from the lever to the spring. As the diaphragm is vibrated, the end of the lever is moved toward and from the spring to close and open the circuit. A screw was provided for adjusting the end of the spring toward and from the end of the lever, and by a proper adjustment the end of the lever may be caused to remain continuously in contact during the vibration of the diaphragm, an undulatory current being thus produced for the transmission of articulate speech. In the latter instrument the diaphragm was horizontal, one contact being carried at its center, while the other comprised a lever resting loosely by its end upon the first contact. As the diaphragm vibrates, the end of the lever is successively thrown away from the diaphragm to open and close the circuit. By this construction it will be observed that the contacts cannot be caused to remain continuously in contact.




A HISTORY OF THE TELEPHONE.

It will be observed that there is a remarkable resemblance between the receiver of Reis and the magneto telephone of Bell, the difference being that Bell secures the thin plate by its edges and provides the armature at its center, while Reis mounts the plate upon a horizontal axis and places the armature upon one end. In both the function of the plates is to beat the air; in both the function of the magnet and armature is to set the plate in motion.

We see, therefore, that Reis actually had a receiver capable of reproducing articulate sounds, had he but understood the necessities of the transmitter, and that by adjusting his transmitter, so that the contacts would remain continuously in contact, he would have had an articulating transmitter. Further than this, had he connected two of his receivers together and used one as a transmitter, speech might have been transmitted. With apparatus of such possibilities, it does, indeed, seem remarkable that the mere oversight of not having turned a screw a fractional rotation on its axis, or of not having connected two particular binding posts by a wire, should have shifted the honor of having first transmitted articulate speech from the shoulders of Reis to those of men living half a generation later.

The apparatus of Reis, as Reis used it, was incapable of transmitting articulate speech, since the only effect of each vibration of the diaphragm was to close the circuit of a battery and send a current impulse over the line. These current impulses being always of the same strength, the vibrating plate of the receiver always produced tones of a given loudness, but as the rate of vibration of the transmitter varied, the rate of vibration of the receiver plate correspondingly varied, the apparatus being thus capable of reproducing the pitch of the sounds. But in complex sounds, and particularly sounds comprising articulate speech, the air particles do not perform a simple to-and-fro movement in constituting the sound, but perform the cycle with more or less complexity, now advancing rapidly, now slower, perhaps receding slightly, and then advancing to complete the stroke, and it is evident that any transmitter that fails to register all of these variations will fail to transmit articulate speech. Since the transmitting diaphragm of the Reis telephone merely registered the completion of the stroke and not the intermediate movements, it was, of course, incapable of transmitting articulate speech.

In the early seventies, Alexander Graham Bell was working upon a harmonic telegraph which, in its essential features, comprises a permanent magnet, opposite the pole of which were located a number of reeds each adapted to vibrate at a different rate. Encircling the magnet was a coil of wire connected with the coil of a similar instrument at a distance. When one of the reeds was set in vibration it executed a definite number of vibrations, the number being peculiar to the reed, and the successive approach of its end to the end of the magnet varied the strength of the magnet, thus inducing in the coil a current which, traversing the coil at the receiving station, varied the strength of the magnet which it encircled to cause the successive attraction of a reed having the same characteristic vibration.

None of the reeds at the receiving station thus vibrate except those whose correspondents at the transmitter vibrate, and if a number of the reeds at the transmitting station are caused to vibrate, the corresponding reeds at the receiving station are set in vibration.

Now, since complex sounds may be resolved into a number of superimposed simple sounds, Bell concluded that if the reeds be mounted flexibly enough to vibrate under the influence of sound waves, and are sufficient in number, a person in speaking against the reeds would set such reeds, the vibration of which when compounded produce the sound, into vibration, thus causing the corresponding reeds at the receiver to vibrate and reproduce the sound. From this conception of the production of all the simple tones of which the complex tone is composed, Bell, taking a lesson from the human ear, advanced to the conception of a diaphragm which should have not a characteristic vibration to respond to a particular sound, but which should respond to all sounds, and the development of this idea led to the production of the magnetic telephone.

Elisha Gray was at this time also working upon a harmonic telegraph, and independently conceived the requisite of speech transmission. His receiver embodied the principle of Bell's telephone, but for a transmitter he provided means for producing changes in the resistance of an electric circuit by the variable immersion in a body of mercury of a needle carried upon the diaphragm, the needle and the mercury being included in the circuit.

It soon became evident that the electro-dynamic or resistance varying telephone of Gray was the best for transmitting the sounds, and the improvements of Berliner, Edison and Blake soon followed. After an interference in the Patent Office, it was decided that Berliner was the first to conceive the use of two electrodes continuously in contact for varying the resistance; that Edison was the first to provide electrodes of carbon, while Blake first mounted the electrodes upon springs in a manner to prevent the breaking of the circuit, and employed platinum as one electrode.

The variations of current produced by solid electrodes is limited, and the transmitter has been improved by Hunning by using granular carbon between a stationary plate and the vibrating diaphragm, a greater variation of resistance for a given movement of the diaphragm being thus secured.

The Hunning transmitter, with improvements for preventing the caking of the granular material, marks the highest stage of development of the telephone transmitter.

Thus we see that the development of the telephone has been a gradual one, and has followed a logical course, and is perhaps one of the most striking examples of the fact that great inventions do not spontaneously emanate from the mind of one great man far in advance of his age, but that each but adds his mite to the amassed knowledge of society, the process continuing until some one happily supplies that last step which, added to what has been done before, carries the undertaking within the pale of success, the last step being perhaps of no greater intrinsic merit than the others, but by virtue of its position, like the keystone that completes the arch, it becomes of the greatest relative importance. The steps when considered in

* Read before the Chicago Electrical Association, January 23, 1894.

the light of retrospect often seem small, indeed, yet they were all necessary to accomplish the completed journey. Thus we see that Morse did little more than provide a key for Sturgeon's electro-magnet. Reis did but little more than substitute for the manual key of Morse one more sensitively constructed to be operated by the vocal organs, and, instead of pounding a metal stop with the armature of the electro-magnet, pounded the air. Bell did but little more than mount the plate of Reis as a diaphragm and conceive the idea of using it as a transmitting instrument to produce the all-essential undulatory current, and in fact all of the variable contact transmitters are but little more than the Reis transmitter properly adjusted. But while we, standing at a distance, are thus able to verify the words, well said, that "science moves but slowly, slowly, creeping on from point to point," we must not forget that the act is more difficult in the performance than in the after contemplation, and that all of those to whom we are indebted for the perfection of the telephone, from Oersted to Hunning, merit our praise, for each has performed an indispensable part.

## THE ORIGIN OF ANTHRACITE.

THE main difference between anthracite and bituminous coal is that the former is devoid of volatile matter. Heretofore the theory generally accepted to account for this difference was that presented a half century ago by Prof. Rogers, while conducting the first geological survey of Pennsylvania. Observing that the anthracite beds lay in the eastern part of the State, in close proximity to the Archean axis of elevation, he surmised that these coal beds had, so to speak, been "cooked" upon the elevation of the Appalachian chain; that is, he supposed that the heat and pressure accompanying the Appalachian elevation, acting most vigorously near the axis, had distilled and removed the volatile matter of the coal beds nearest it.

To adjust the theory to increasing facts, Prof. Lesley added the supposition that the heat involved in this theory was brought up by conduction when the superincumbent layers of rock were extremely thick, which have since been mainly removed by the erosive agencies which have been active over the region for millions of years.

The inadequacy of these theories has led Prof. J. J. Stevenson, of the University of New York, to propound another and simpler theory, which was ably defended by him at the recent meeting of the Geological Society of America.

He would account for the lack of volatile matter in anthracite coal by the simple fact that it had been longer exposed to that kind of decay which takes place in vegetable matter when immersed in water, a decay which consists chiefly in the loss of the hydrocarbons, which constitute the volatile elements in bituminous coal. On this supposition the anthracite beds are those which were formed earliest in the swamps and lagoons of the carboniferous period and remained longest devoid of the covering of sedimentary deposits which subsequently preserved them from further change.

This theory is confirmed by the fact that there is no such strict relation of the anthracite beds to the Appalachian axis of elevation as Prof. Rogers had supposed, and by many other considerations which Prof. Stevenson is about to publish. This simple cause seems adequate to account for all the phenomena, and probably solves one of the long-standing mysteries of geological science.

## ISOPERIMETRICAL PROBLEMS.*

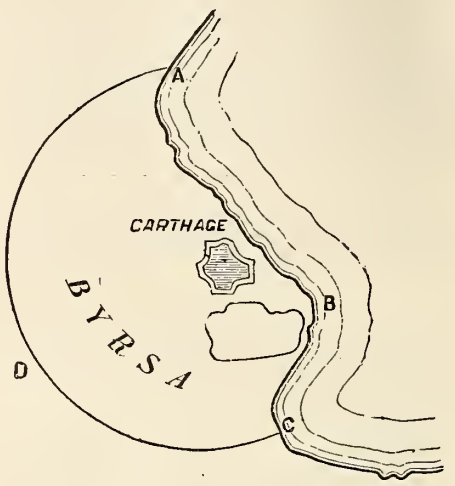
By LORD KELVIN.

Dido, B. C. 800 or 900.
Horatius Cocles, B. C. 508.
Pappus, Book v. A. D. 390.
John Bernoulli, A. D. 1700.
Euler, A. D. 1744.
Maupertuis (Least Action), b. 1698, d. 1759.
Lagrange (Calculus of Variations), 1759.
Hamilton (Actional Equations of Dynamics), 1834.
Liouville, 1840 to 1860.

THE first isoperimetrical problem known in history was practically solved by Dido, a clever Phenician princess, who left her Tyrian home and emigrated to North Africa, with all her property and a large retinue, because her brother Pygmalion murdered her rich uncle and husband Acerbas, and plotted to defraud her of the money which he left. On landing in a bay about the middle of the north coast of Africa she obtained a grant from Hiarbas, the native chief of the district, of as much land as she could inclose with an ox hide. She cut the ox hide into an exceedingly long strip, and succeeded in inclosing between it and the sea a very valuable territory† on which she built Carthage.

The next isoperimetrical problem on record was three or four hundred years later, when Horatius Cocles, after saving his country by defending the bridge until it was destroyed by the Romans behind him, saved his own life and got back into Rome by swimming the Tiber under the broken bridge, and was rewarded by his grateful countrymen with a grant of as much land as he could plow round in a day.

In Dido's problem the greatest value of land was to be inclosed by a line of given length. If the land is all of equal value, the general solution of the problem shows that her line of ox hide should be laid down in a circle. It shows also that if the sea is to be part of the boundary, starting, let us say, southward from any *given* point A of the coast, the inland bounding line must at its far end cut the coast line perpendicularly. Here, then, to complete our solution, we have a very curious and interesting, but not at all easy, geometrical question to answer: What must be the radius of a circular arc A D C, of given length, and in what direction must it leave the point A, in order that it may cut a given curve A B C perpendicularly at some unknown point, C? I do not believe Dido could have passed an examination on the subject, but no doubt she gave a very good practical solution, and better than she would have found if she had just mathematics enough to make her fancy the boundary ought to be a circle. No doubt she gave it different curvature in different parts to bring in as much as possible of the more valuable parts of the land offered to her, even though difference of curvature in different parts would cause the total area




inclosed to be less than it would be with a circular boundary of the same length.

The Roman reward to Horatius Cocles brings in quite a new idea, now well known in the general subject of isoperimetrics; the greater or less speed attainable according to the nature of the country through which the line traveled over passes. If it had been equally easy to plow the furrow in all parts of the area offered for inclosure, and if the value of the land per acre was equal throughout, Cocles would certainly have plowed as nearly in a circle as he could, and would only have deviated from a single circular path if he found that he had misjudged its proper curvature. Thus, he might find that he had begun on too large a circle, and, in order to get back to the starting point and complete the inclosure before nightfall, he must deviate from it on the concave side; or he would deviate from it on the other side if he found that he had begun on too small a circle, and that he had still time to spare for a wider sweep. But, in reality, he must also have considered the character of the ground he had to plow through, which cannot but have been very unequal in different parts, and he would naturally vary the curvature of his path to avoid places where his plowing must be very slow, and to choose those where it would be most rapid.

He must also have had, as Dido had, to consider the different value of the land in different parts, and thus he had a very complex problem to practically solve. He had to be guided both by the value of the land to be inclosed and the speed at which he could plow according to the path chosen; and he had a very brain-trying task to judge what line he must follow to get the largest value of land inclosed before night.

These two very ancient stories, whether severe critics will call them mythical or allow them to be historic, are nevertheless full of scientific interest. Each of them expresses a perfectly definite case of the great isoperimetrical problem to which the whole of dynamics is reduced by the modern mathematical methods of Euler, Lagrange, Hamilton and Liouville (Liouville's Journal, 1840–1850). In Dido's and Horatius Cocles' problems, we find perfect illustrations of all the fundamental principles and details of the generalized treatment of dynamics which we have learned from these great mathematicians of the eighteenth and nineteenth centuries.

Nine hundred years after the time of Horatius Cocles we find, in the fifth book of the collected Mathematical and Physical Papers of Pappus, of Alexandria, still another idea belonging to isoperimetrics—the economy of valuable material used for building a wall; which, however, is virtually the same as the time per yard of furrow in Cocles' plowing. In this new case the economist is not a clever princess, nor a patriot soldier, but a humble bee who is praised in the introduction to the book not only for his admirable obedience to the authorities of his republic, for the neat and tidy manner in which he collects honey, and for his prudent thoughtfulness in arranging for its storage and preservation for future use, but also for his knowledge of the geometrical truth that a "hexagon can inclose more honey than a square or a triangle with equal quantities of building material in the walls," and for his choosing on this account the hexagonal form for his cells. Pappus, concluding his introduction with the remark that bees only know as much of geometry as is practically useful to them, proceeds to apply what he calls his own superior human intelligence to investigation of useless knowledge, and gives results in his Book V. which consists of fifty-five theorems and fifty-seven propositions on the areas of various plane figures having equal circumferences. In this book, written originally in Greek, we find (Theorem IX., Proposition X.) the expression "isoperimetrical figures," which is, so far as I know, the first use of the adjective "isoperimetrical" in geometry; and we may, I believe, justly regard Pappus as the originator, for mathematics, of *isoperimetrical problems*, the designation technically given in the nineteenth century* to that large province of mathematical and engineering science in which different figures having equal circumferences, or different paths between two given points, or between some two points on two given curves, or on one given curve, are compared in connection with definite questions of greatest efficiency and smallest cost.

In the modern engineering of railways, an isoperimetrical problem of continual recurrence is the laying out of a line between two towns along which a railway may be made at the smallest prime cost. If this were to be done irrespectively of all other considerations, the requisite datum for its solution would be simply the cost per yard of making the railway in any part of the country between the two towns. Practically the solution would be found in the engineers' drawing office by laying down two or three trial lines to begin with, and calculating the cost of each, and choosing the one of which the cost is least. In practice various other considerations than very slight differences in the cost of construction will decide the ultimate choice of the exact line to be taken; but if the problem were put before a capable engineer to find very exactly the line of minimum total cost, with an absolutely definite statement of the cost per yard in every part of the country, he or his draughtsmen would know perfectly how to find the solution. Having found something near the true line by a few rough trials, they would try small deviations from the rough approximation, and calculate differences of cost for different lines differing very little from one another. From their drawings and calculations they would judge by eye which way they must deviate from the best line already found to find one still better. At last they would find two lines for which their calculation shows no difference of cost. Either of these might be chosen; or, according to judgment, a line midway between them, or somewhere between them, or even not between them, but near to one of them, might be chosen, as the best approximation to the exact solution of the mathematical problem which they care to take the labor of trying for. But it is clear that if the price per yard of the line were accurately given (however determined or assumed), there would be an absolutely definite solution of the problem, and we can easily understand that the skill available in a good engineer's drawing office would suffice to find the solution with any degree of accuracy that might be prescribed; the minuter the accuracy to be attained, the greater the labor, of course. You must not imagine that I suggest, as a thing of practical engineering, the attainment of minute accuracy in the solution of a problem thus arbitrarily proposed; but it is interesting to know that there is no limit to the accuracy to which this ideal problem may be worked out by the methods which are actually used every day by engineers in their calculations and drawings.

The modern method of the "calculus of variations," brought into the perfect and beautiful analytical form in which we now have it by Lagrange, gives for this particular problem a theorem which would be very valuable to the draughtsman if he were required to produce an exceedingly accurate drawing of the required curve. The curvature of the curve at any point is convex toward the side on which the price per unit length of line is less, and is numerically equal to the rate per mile perpendicular to the line at which the Neperian logarithm of the price per unit length of the line varies. This statement would give the radius of curvature in fraction of a mile. If we wish to have it in yards, we must take the rate per yard at which the Neperian logarithm of the price per unit length of the line varies. I commend the Neperian logarithm of price in pounds, shillings and pence to our honorary secretary, to whom no doubt it will present a perfectly clear idea; but less powerful men would prefer to reckon the price in pence, or in pounds and decimals of a pound. In every possible case of its subject the "calculus of variations" gives a theorem of curvature less simple in all other cases than in that very simple case of the railway line of minimum first cost, but always interpretable and intelligible according to the same principles.

Thus in Dido's problem we find by the calculus of variations that the curvature of the inclosing line varies in simple proportion to the value of the land at the places through which it passes; and the curvature at any one place is determined by the condition that the whole length of the ox hide just completes the inclosure.

The problem of Horatius Cocles combines the railway problem with that of Dido. In it the curvature of the boundary is the sum of two parts; one, as in the railway, equal to the rate of variation perpendicular to the line, of the Neperian logarithm of the cost in time per yard of the furrow (instead of cost in money per yard of the railway); the other varying proportionally to the value of the land as in Dido's problem, but now divided by the cost per yard of the line, which is constant in Dido's case. The first of these parts, added to the ratio of the money value per square yard of the land to the money cost per lineal yard of the boundary (a wall suppose), is the curvature of the boundary when the problem is simply to make the most you can of a grant of as much land as you please to take provided you build a proper and sufficient stone wall round it at your own expense. This problem, unless wall building is so costly that no part of the offered land will pay for the wall round it, has clearly a determinate finite solution if the offered land is an oasis surrounded by valueless desert. It has also a determinate finite solution even though the land be nowhere valueless, if the wall is sufficiently more and more expensive at greater and greater distances from some place where there are quarries, or habitations for the builders.

The simplified case of this problem, in which all equal areas of the land are equally valuable, is identical with the old well-known Cambridge dynamical plane problem of finding the motion of a particle relatively to a line of reference revolving uniformly in a plane; to which belongs that considerable part of the "Lunar Theory" in which any possible motion of the moon is calculated on the supposition that the center of gravity of the earth and moon moves uniformly in a circle round the sun, and that the motions of the earth and moon are exactly in this plane. The rule for curvature which I have given you expresses in words the essence of the calculation, and suggests a graphic method for finding solutions by which not uninteresting approximations * to the cusped and looped orbits of G. F. Hill† and Poincaré‡ can be obtained without disproportionately great labor.

* A lecture delivered at the Royal Institution, May 12, 1893, by Lord Kelvin, Pres. R.S.—*Nature*.

† Called Byrsa, from βύρσα, the hide of a bull. (Smith's "Dictionary of Greek and Roman Biography and Mythology," article "Dido.")

* Example, Woodhouse's "Isoperimetrical Problems," Cambridge, 1810.

* Kelvin "On Graphic Solution of Dynamical Problems." *Phil. Mag.*, 1892 (second half year).

† Hill, "Researches in the Lunar Theory," Part 3. "National Academy of Sciences," 1887.

‡ "Methodes Nouvelles de la Mecanique Celeste," p. 109 (1892).

In the dynamical problem, the angular velocity of the revolving line of reference is numerically equal to half the value of the land per square yard; and the relative velocity of the moving particle is numerically equal to the cost of the wall per lineal yard in the land question.

But now as to the proper theorem of curvature for each case; both Dido and Horatius Cocles no doubt felt it instinctively and were guided by it, though they could not put it into words, still less prove it by the "calculus of variations." It was useless knowledge to the bees, and, therefore, they did not know it; because they had only to do with straight lines. But as you are not bees I advise you all, even though you have no interest in acquiring as much property as you can inclose by a wall of given length, to try Dido's problem for yourselves, simplifying it, however, by doing away with the rugged coast line for part of your boundary, and completing the inclosure by the wall itself. Take forty inches of thin soft black thread with its ends knotted together and let it represent the wall; lay it down on a large sheet of white paper and try to inclose the greatest area with it you can. You will feel that you must stretch it in a circle to do this, and then, perhaps, you will like to read Pappus (Liber V., Theorema II., Propositio II.) to find mathematical demonstration that you have judged rightly for the case of all equal areas of the inclosed land equally valuable. Next try a case in which the land is of different value in different parts.

Take a square foot of white paper and divide it into 144 square inches to represent square miles, your forty inches of endless thread representing a forty mile wall to inclose the area you are to acquire. Write on each square the value of that particular square mile of land, and place your endless thread upon the paper, stretched round a large number of smooth pins stuck through the paper into a drawing board below it, so as to inclose as much value as you can, judging first roughly by eye and then correcting according to the sum of the values of complete squares and proportional values of parts of squares inclosed by it. In a very short time you will find with practical accuracy the proper shape of the wall to inclose the greatest value of the land that can be inclosed by forty miles of wall. When you have done this you will understand exactly the subject of the calculus of variations, and those of you who are mathematical students may be inclined to read Lagrange, Woodhouse, and other modern writers on the subject.

The problem of Horatius Cocles, when not only the different values of the land in different places but also the different speed of the plow according to the nature of the ground through which the furrow is cut are taken into consideration, though more complex and difficult, is still quite practicable by the ordinary graphic method of trial and error. The analytical method of the calculus of variations, of which I have told you the result, gives simply the proper curvature for the furrow in any particular direction through any particular place. It gives this and it cannot give anything but this, for any plane isoperimetrical problem whatever, or for any isoperimetrical problem on a given curved surface of any kind.

Beautiful, simple, and clear as isoperimetrics is in geometry, its greatest interest, to my mind, is in its dynamical applications. The great theorem of least action, somewhat mystically and vaguely propounded by Maupertuis, was magnificently developed by Lagrange and Hamilton, and by them demonstrated to be not only true throughout the whole material world, but also a sufficient foundation for the whole of dynamical science.

It would require nearly another hour if I were to explain to you fully this grand generalization for any number of bodies moving freely, such as the planets and satellites of the solar system, or any number of bodies connected by cords, links, or mutual pressures between hard surfaces, as in a spinning wheel, or lathe and treadle, or a steam engine, or a crane, or a machine of any kind; but even if it were convenient to you to remain here an hour longer I fear that two hours of pure mathematics and dynamics might be too fatiguing. I must, therefore, perforce limit myself to the two dimensional, but otherwise wholly comprehensive, problems of Dido and Horatius Cocles. Going back to the simpler included case of the railway of minimum cost between two towns, the dynamical analogue is this: For price per unit length of the line substitute the velocity of a point moving in a plane under the influence of a given conservative system of forces, that is to say, such a system that when material particles not mutually influencing one another are projected from one and the same point in different directions, but with equal velocities, the subsequent velocity of each is calculable from its position at any instant, and all have equal velocities in traveling through the same place whatever may be their directions. The theorem of curvature, of which I told you in connection with the railway engineering problem, is now simply the well-known elementary law of relation between curvature and centrifugal force of the motion of a particle.

The motion of a particle in a plane is, as Liouville has proved, a case to which every possible problem of dynamics involving just two freedoms to move can be reduced. But to bring you to see clearly its relation to isoperimetrics, I must tell you of another admirable theorem of Liouville's, reducing to a still simpler case the most general dynamics of two freedoms motion. Though not all mathematical experts, I am sure you can all perfectly understand the simplicity of the problem of drawing the shortest line on any given convex surface, such as the surface of this block of wood (shaped to illustrate Newton's dynamical theory of the elliptic motion of a planet round the sun) which you see on the table before you.

I solve the problem practically by stretching a thin cord between the two points, and pressing it a little this way or that way with my fingers till I see and feel that it lies along the shortest distance between them. And now, when I tell you that Liouville has reduced to this splendidly simple problem of drawing a shortest line (geodetic line it is called) on any given curved surface every conceivable problem of dynamics involving only two freedoms to move, I am sure you will understand sufficiently to admire the great beauty of this theorem.

The doctrine of isoperimetrical problems in its relation to dynamics is very valuable in helping to theoretical investigation of an exceedingly important subject for astronomy and physics—the stability of motion, regarding which, however, I can only this evening venture to show you some experimental illustrations.

The lecture was concluded with experiments illustrating:

1. Rigid bodies (teetotums, boys' tops, ovals, oblates, etc.) placed on a horizontal plane, and caused to spin round on a vertical axis, and found to be thus rendered stable or unstable according as the equilibrium without spinning is unstable or stable.
2. The stability or instability of a simple pendulum, whose point of support is caused to vibrate up and down in a vertical line, investigated mathematically by Lord Rayleigh.
3. The crispations of a liquid supported on a vibrating plate, investigated experimentally by Faraday; and the instability of a liquid in a glass jar, vibrating up and down in a vertical line, demonstrated mathematically by Lord Rayleigh.
4. The instability of water in a prolate hollow vessel, and its stability in an oblate hollow vessel, each caused to rotate rapidly round its axis of figure,* which were announced to Section A of the British Association at its Glasgow meeting in 1876 as results of an investigation not then published, and which has not been published up to the present time.

## BASIC SULPHATE OF ALUMINA.

ACCORDING to a paper read by Mr. W. C. Ferguson, before the American Chemical Society, many samples of commercial sulphate of alumina contain more or less of an excess of alumina over that required to form the normal sulphate ($Al_2(SO_4)_3$), the amount varying from a trace to 2½ per cent. and occasionally even more.

The following composition is of frequent occurrence: Total soluble alumina = 17·00 per cent.; soluble alumina calculated from sulphuric anhydride ($SO_3$) to form $Al_2(SO_4)_3$ = 15·2 per cent., leaving 1·8 per cent. of alumina in excess of that required to form the normal sulphate.

It is concerning the probable chemical constitution of this alumina in excess of that required to form the normal sulphate, together with its behavior toward resin soap in the manufacture of paper, that this brief article is written.

As is well known, in sizing paper, sulphate of alumina is made to react on resin soap (made by saturating soda ash with resin), thus precipitating an insoluble alumina soap, a resinate of alumina in the fiber of the paper.

In many paper works the per cent. of normal sulphate $Al_2(SO_4)_3$ determines the strength of the material bought and, other things being favorable, that is preferred which contains the highest per cent. of $Al_2(SO_4)_3$.

A number of reports from paper mills are about as follows:

| | |
|---|---|
| Combined $Al_2O_3$ | = 15·20 = $Al_2(SO_4)_3$ = 50·96 |
| Free $Al_2O_3$ | = 1·80, or |
| $Al_2(SO_4)_3$ | = 50·96 |
| $Al_2O_3$ | = 1·80 |

In such reports the "combined" $Al_2O_3$ and also the $Al_2(SO_4)_3$ are calculated from the $SO_3$ present and the souluble so-called "free" $Al_2O_3$ is ignored as being of no value for sizing purposes. This idea, that has so little, if anything, to support it, is discussed below.

A solution of normal sulphate of alumina behaves very much like an acid; it combines with bases, evolves hydrogen with metals, and is acid to litmus paper. We should, therefore, expect $SO_3$ to combine with more alumina than is represented by the normal sulphate, and it might be added that as weak bases have the characteristic of forming basic salts, we should for this reason also anticipate the formation of basic sulphates of alumina. These basic sulphates can readily be formed in the laboratory from the normal sulphate.

1. By dissolving alumina in the normal sulphate.
2. By action of caustic alkalies on a solution of the normal sulphate. $Al_2(SO_4)_3 + Na_2O = Al_2O_3(SO_3)_2 + Na_2SO_4$.

For example: A solution of normal sulphate of alumina containing seven per cent. of alumina can be made two per cent. basic by adding caustic soda slowly to a hot solution until a precipitate forms that does not dissolve even on long boiling. This is equivalent in a seventeen per cent. material to having 4·86 per cent in excess of that required to form $Al_2(SO_4)_3$.

3. By action of a metal, $Al_2(SO_4)_3 + Zn + H_2O = ZnSO_4 + Al_2O_3(SO_3)_2 + H_2$.

These equations are only intended to illustrate the probable types of reaction; it is not assumed that just such compounds are formed.

The following standard works treat of a number of basic sulphates of alumina that are soluble in water: Watts' "Dictionary of Chemistry," Roscoe and Schorlemmer's "Chemistry," Mendelejeff's "Principles of Chemistry." A careful search through the literature fails to reveal any reference to "free" alumina existing in a solution of normal sulphate.

The term "free" implies the reverse of combined, and from the considerations given above it is not deemed best to call the alumina contents in excess of that required to form normal sulphate "free," with every condition favoring combination. Such alumina is undoubtedly combined as basic sulphate, and being in solution there is every reason to believe that it would form a resinate of alumina with resin soap as readily as the normal sulphate, and some ground for the assumption that it might be even more available, because it is probably held in weaker combination, and so would be more readily decomposed and precipitated as size; and if this were true, such basic alumina would be more valuable than the normal, because more would be precipitated by a given weight of resin soap. With these considerations in mind the following investigations were carried out in the laboratory. In order to observe the action of resin soap on a solution in which the alumina approaches nearest to the free state, some aluminate of soda was prepared by dissolving alumina in caustic soda. In this solution alumina is so feebly held in combination that the weakest acids, such as carbonic, will replace it. The solution is basic, and alkaline to test paper.

Resin soap immediately precipitates a voluminous precipitate of resinate of alumina. Even upon the addition of a drop or two of resin soap the precipitate begins to form.

A comparison of a neutral sulphate containing 17 per cent. soluble alumina and of a basic sulphate containing 17 per cent. total soluble alumina, 15 per cent. being normal and 2 per cent. being basic (the so-called "free"), were each treated with an equal amount of resin soap in such quantity that but a portion of the alumina was precipitated. The solutions were filtered and precipitates washed with equal amounts of water and ignited. It was found that under such conditions

4·40 grammes were precipitated from the neutral solution,
6·98 grammes were precipitated from the basic solution.

These results are what theory would anticipate.

A brief summary of the case is this: It would seem that there is no "free" soluble alumina in the basic sulphate of alumina of commerce; such alumina is in direct combination as basic sulphate, and being more feebly held in combination than alumina combined as normal sulphate, more readily forms size with resin soap and is therefore more economical, less resin soap being required for a given weight of sulphate. It directly follows from this that in any sulphate of alumina the $Al_2(SO_4)_3$ should be calculated from the total soluble alumina and *not* from that combined as normal sulphate alone, as in the latter case the most valuable alumina content is ignored as being useless. The following example will serve to illustrate the difference in value based on the two types of analyses: In a sulphate of alumina analyzing

| | |
|---|---|
| Total soluble alumina..... ..... | 17·00 per cent. |
| Alumina combined as normal | 15·20 " |
| Basic alumina=so-called "free" | 1·80 " |

The $Al_2(SO_4)_3$ calculated from 15·20 per cent. of alumina equals 50·96 per cent., whereas if calculated from 17·00 per cent., the $Al_2(SO_4)_3$ equals 57·00 per cent. In conjunction with these figures it must be borne in mind that experiment proves the basic sulphate of alumina to be relatively even more efficient than the difference in the above interpretations of the analysis indicates.

## CARBON IN THE SUN.

WHAT it concerns us specially to notice is that among elements which may be deemed refractory, that is to say, among elements which retain the solid or the liquid state until a temperature has been attained high enough to drive most other substances into vapor, the molecular mass of carbon is exceptionally small. We may, in fact, assert that so far as elements which are likely to exist in abundance on the sun are concerned, the case of carbon is unique. This element combines an excessively high refractory nature with an excessively low molecular mass. It will not be hard to deduce from these facts Dr. Stoney's very remarkable conclusion that carbon is the effective constituent of the clouds in the photosphere. It is, indeed, very interesting to trace out the ingenious line of reasoning by which this conclusion is established. I shall here give an outline of the argument.

Picture the condition of affairs in the upper part of the solar atmosphere, where the vapors of many elements are commingled. At the same distance from the center of the sun we may assume that the temperatures are equal. This being so, the several molecules of the different elements in the mixture will be moving with varied velocities, corresponding on the average to their various molecular weights. Specially noticeable among them will be the molecules of carbon. They are in great abundance, and they are distinguished from the great majority of the substances with which they are associated by the high speed at which they are generally darting along. Their motions are of course pursued in every direction, myriads of molecules are flying downward, myriads are flying horizontally, myriads are flying upward. It is these last which are at present important.

As a molecule is flying upward it experiences not alone all the chance encounters with the other molecules, but it is also directly subjected to a reduction of its velocity in consequence of the gravitation of the sun. That gravitation is vehement in proportion to the great mass of the sun. Thus the attraction of the sun on the molecules must be about twenty-five times the attraction which the earth exerts on bodies near its surface. Those molecules which move comparatively slowly must in their occasional vertical flights respond to the solar attractions more promptly than the molecules better endowed with velocity. It thus appears that, when the molecules of carbon happen to be darting upward and outward from the sun, their comparatively high velocities will enable them to attain generally greater altitude in the solar atmosphere than is permitted to the molecules of a less lively character. Thus we see that the molecules of carbon will on the whole tend to soar aloft to greater altitudes than are attained by the majority of solar materials.

This consideration excludes a number of elements from possible participation in the clouds of the photosphere. Their molecular velocities are not sufficient to maintain them at the necessary altitudes. But among the elements which are permitted to elevate themselves sufficiently, carbon now assumes a distinctly prominent position in virtue of the other remarkable property of this element to which we have referred. It is certain that the greater the distance from the solar center, the lower must be the temperature to which the materials are exposed. No doubt in the interior of the sun the temperature is so high that even carbon must be there permanently gaseous. But at a sufficient altitude above the sun's surface, or to speak more accurately, at a sufficient distance from the sun's center, the temperature is low enough to permit the carbon vapors to return to the liquid state, and thus gather into the beads of liquid glowing carbon which forms the luminous cloud. What then happens is clearly of the following nature. The high velocities of the carbon molecules are ever and anon conducting them to elevations in the

* *Nature*, 1877, vol. xv., p. 297, "On the Precessional Motion of a Liquid."

solar atmosphere, where the temperature is sufficiently low to reduce the carbon vapors to the cloudy state which they are so prone assume. Herein lies the essential difference between carbon and the other elements. In the first place, many of the elements never possess sufficient molecular velocities to carry them in any large quantities into the elevated regions. In the second place, among the elements which can attain sufficient altitudes carbon is the most refractory, and therefore would be the first to take that step in condensation implied by its transformation into a cloud. On these grounds Dr. Stoney has concluded that the same element which is the great source of artificial light in almost all forms on this earth, is also the source of solar light. Our conception of the important functions of carbon in the universe is thus greatly extended.—*Sir Robert Ball, in the Fortnightly Review.*

## "MISTI"—HARVARD'S NEW OBSERVATORY.

THE volcano, so called, of which we give a view, is situated on a spur of the Andes near Arequipa, Peru. It is notable for its conical figure and for its elevation. It is situated in 16° 17′ latitude, and 73° 39′ longitude. Its height is a little over 6,000 meters = 19,300 feet. There is no tradition in respect to the epoch in which it was in eruption, but it must have been before the time of the Incas, and it is undoubtedly now extinguished.

Prior to 1858, no one had been able to reach its summit, although Haenke, Pentland and others had made attempts. The first who succeeded was the naturalist Weddell; since then many persons have made the ascent. The ascent is attended with much fatigue, not only by reason of the great elevation, but because the mountain is covered with loose ashes.

In August last an expedition was sent out to make the complete circuit of this volcano, with the object of studying the possibility of making a mule road to the top. Minute observations were made with good telescopes of all sides of the mountain, and we took some photographs. Seen from whatever direction, Misti presents a surprising symmetry, always showing a cone more or less truncated, but almost perfect. This examination convinced me the mountain was accessible from the northeast. In August a stone cabin was erected on the northeast side of the volcano as a station, and here I stayed several days watching the construction of the road to the summit. Without leaving the great slopes of volcanic sand and avoiding the sharp rocks, it did not prove to be an impossible enterprise, as many have feared.

On the 27th of September, 1893, I had the pleasure of reaching the summit with my assistant, several Indians and two mules. Going on foot and on mule back alternately, we arrived in good condition to make scientific observations, and the mules were not seriously injured. The altitude, however, produced a great effect upon the mules, and when near the top they refused to go more than twenty steps at a time without taking a good rest. Without such extreme care, it is probable they would have succumbed.

On the 12th of October I returned to visit the summit with two members of the observatory, twelve Indians, and thirty mules, transporting a portable house of wood, with double walls. We also carried a small house for instruments, together with the instruments necessary for the station work. Provisions were sent to our stone cabin, where we pass the night at an altitude of 16,000 feet, more or less; without this precaution the ascension would have been impossible. Some of the members of the committee suffered seriously from breath exhaustion (*soroche*), and only by great exertions did the men and mules succeed in reaching the summit. In many places it was necessary that two men should assist each of the mules that bore the heavy parts of the house. On this expedition one of the mules stumbled and went down a rocky declivity and was considerably hurt; happily its burden consisted of clothing and other articles which were not damaged by the fall.

The station consists at present of two little houses, one for the observers and the other for the instruments. They have been located at a short distance from the iron cross, which, for more than a century, has formed so fitting a crown for the mountain. The station is provided with an automatic barometer, indicator, thermograph, hygrometer and anemometer, together with various mercurial thermometers. The first named automatic instruments run ten days, and a member of the observatory will visit the station three times a month.

The height of the station, according to determinations made by various barometric observations, is 19,300 feet above the level of the sea.

For the government and citizens of the country who have so generously lent their assistance and confidence to this observatory, it ought to be a matter of pride that Peru not only possesses some of the sublimest scenery, but also has given to science the highest meteorological station in the world.

"MISTI," HARVARD'S NEW OBSERVATORY.

The crater is encompassed by a species of granite wall, which forms a great basin in the shape of a funnel, filled in the center with ashes. So says *La Ilustracion Sud Americana*, from which our engraving is taken.

Misti is now occupied as a meteorological station by Harvard University.

We are indebted to Dr. S. I. Bailey, of the Harvard Observatory, Arequipa, Peru, for a copy of *La Bolsa*, of that city, containing an account by him of the establishment of the Harvard Meteorological Station on the summit of Misti, not far from Arequipa.

We translate the following abstract: Well knowing the interest which Peruvians take in scientific progress, and especially in all observations made in connection with the famous volcano of Arequipa, I have the pleasure of giving you the following particulars concerning the meteorological station recently established on the summit of Misti. In order to equip and put this station into operation, a road for mules was very much desired; for, although one might be able to go on foot to the summit once or twice, it would be very difficult, without such a road, for an intelligent person to visit the station regularly and make the necessary observations. The experience of persons who have ascended to great heights has been, in general, that the fatigue due to the extraordinary exertions has disabled them from making exact observations. We have never heard it said that mules have ascended to so great a height as the summit of Misti; but previous experience with these animals at heights of 17,000 feet convinced me that, with proper care, mules might ascend to a height of 19,000 or even 20,000 feet.

Of all the mountains in the neighborhood of Arequipa, Misti, by its splendid isolation and symmetry, is the most adequate for a prominent meteorological station.

## TRIPOLI IN THE SPRING.

A VISIT to Tripoli in the mouth of March is as delightful a holiday as any one need wish for. The intense heat of summer has not yet set in, and you experience the warmth of our July, combined with a brighter sunshine. Tripoli occupies an oasis on the edge of the Great Desert; outside the walled town a fertile sandy tract of land extends along the shore for some miles, and here you revel amid many novel and marvelous sights. There are miles of palm groves where the trees tower up as straight as ships' masts, and where the dates will soon hang in huge clusters from the feathery crowns. There are vast tracts of orange gardens, where you may for a few pence wander among fragrant groves, plucking and eating the luscious golden fruit as it hangs above your head. There is but little or no tide at Tripoli, and the bright strip of golden shore is like a moving panorama of pictures, such as we never see in our northern clime. Camels are here by the hundred, lying down, roaring, and chewing the cud, or walking along with stately pace, head high in the air; ragged, ill-favored camels; camels with rich, thick, brown fur or hair; light colored, dark, old and young. The Arabs, swathed from head to foot in blankets, ride or walk alongside, with long fowling pieces over their shoulders.

Negroes there are in plenty, and of the blackest hue, from the far Soudan, jolly-looking and merry, and, perchance, clothed in many-colored rags. The esparto grass forms one of the chief articles of trade between Tripoli and England. It is found in the desert a few days' journey from Tripoli. Long strings of camels may be constantly seen on the shore making for the various esparto yards, each camel carrying about three cwt. of grass. The negroes are good steady workers; they pick the grass, throwing out the bad. It is packed into close bales by hydraulic pressure, bound round with iron bands, and is shipped off in steamers to England, where it is converted into paper. The negroes live in colonies among the palm trees, and a visit to their quarters reminds one of books of travel by African explorers. The huts are like beehives in shape, and are entered in the same way by a low half-round doorway. Each hut owns a small plot of ground which is surrounded by palisading, *a la* Robinson Crusoe, and many of the owners jealously close the door on the appearance of a stranger. The women of the family sit about on the ground making colored baskets, while their charming black babies roll about on the sandy ground enjoying life to the full.

A walk of two or three miles across the breadth of Tripoli brings you to the edge of the Great Desert, the most wonderful sight of the many that Tripoli can furnish. Here you may stand among the palm trees, gazing over a waste of sand, with its distant mountain ridge, a great arid plain, extending away "for six months." Such a vast extent of utter loneliness is awe-inspiring, and it may be revisited again and again without losing its fascinating charm. As you stand gazing over this limitless, uneven plain of sand a few dark specks appear on the horizon; gradually they draw nearer, winding along like a great black snake; and soon you distinguish the forms of many camels loaded with esparto grass, their Arab owners walking alongside through the hot sand and under a scorching sun. They enter the fringe of palm trees, and another hour will bring them to their journey's end. The sun is setting, and the scene grows in solemnity, not a bird nor an animal to break the silence; only the burning waste of sand stretching away "for six months." Twilight falls; a crimson flush spreads over the horizon, extending over the sky, and gradually blending through an infinite variety of colors with the deep blue overhead. So we turn away from the edge of the Great Desert of Sahara to wander back to Tripoli through the darkening lanes, under the shadows of the tall, ghostly palm trees.—*The Graphic, London.*

## CŒLOGYNE MOSSIÆ.

ROLFE, *n. sp.*

OUR illustration affords a representation of the pretty and new Cœlogyne, which was exhibited by J. S. Moss, Esq., Wintershill, Bishop's Waltham, Hants (gardener, Mr. Bazeley), at the Royal Horticultural Society's meeting of the orchid committee on March 13, when it was awarded a first-class certificate. Its spray of white flowers was much admired, and it was duly noticed in our issue of March 17.

Like many another fine introduction, it is to an amateur's endeavors that the arrival of this pretty plant in our gardens is due. It was sent to Mr. Moss by a friend in the Neilgherry district, of India, in 1887; two plants coming in a box with some other orchids. It bloomed for the first time in 1890, but it was not until recently that it got named. At present there are four plants of it, and some back bulbs which may make another, but we trust that a larger importation of the species will be made, so that it may be distributed, and take that place in gardens which its beauty entitles it to.—*The Gardeners' Chronicle.*

## THE WORLD'S COLUMBIAN EXPOSITION FROM A BOTANICAL STANDPOINT.*

By HENRY KRAEMER.

THE botany of the World's Columbian Exposition may be said to have been a subject of at least some interest to every one that visited the Fair. And while attention has been called to the fact that in only three places in the great Exposition did one see the placard with the name "Botany," still it was important and noteworthy that three buildings were entirely devoted to the exhibition of some of the products of the vegetable kingdom and that all of the others contained more or less exhibits of a botanical nature. Much may be said regarding the momentary inspiration one received upon beholding the building and grounds for the first time. It might be coupared to that of an ideal realized and personified. In reality it was akin to that which one receives upon beholding a young man (say on his commencement day) whose powers are not only strong, but whose pecuniary position is as strong and whose every action is a story of ideal endeavors and splendid successes.

CŒLOGYNE MOSSIÆ, ROLFE, *ined.* FLOWERS WHITE.

In endeavoring to select that which will be of interest to us and of bearing upon our subject to-day we must forego mention, certainly in detail, of those objects which are likely to be seen again or are of a purely external character. For convenience let us first look into that building which was one of the most conspicuous at the Exposition—the Agricultural building. In this building 37 of the States of the United States and 35 foreign nations had exhibits. The nations and States participating utilized their principal products in the construction and ornamentations of their pavilions. The medicinal specimens were not, generally speaking, of much interest, not so much because these were not interesting exhibits, but mainly because the arrangement, labeling and nomenclature were so poor that it was difficult without considerable labor to obtain even the slightest information relating thereto. Mention may be made of eucalyptus oils; an assorted Cape gum, being an exudation from Acacia horrida; a solid block of Cape aloes, 18 inches wide, 2 feet high and 1 foot thick. Several blocks of honey and wax of about 50 pounds each. Rolls of cinnamon, with cinnamon peelers' tools.

More attention was paid to the agricultural and economic side of botany than to the medicinal side. Woods of all kinds were displayed, being worked up and polished to show their especial adaptability to all kinds of ornamental and useful work. An interesting product was a quantity of cassava bread (see *Amer. Jour. Pharm.*, 1891, 391). Canada exhibited a section of Prunus virginiana, 44 inches in diameter. Ceylon exhibited tea and coffee from more than 100 estates, one sample of tea being valued at $175 per pound. Germany exhibited the processes for, and products resulting from, the manufacture of sugar from the beet root, of spirit from potatoes, of starch from potatoes, of starch sugar by the inversion of potato starch, of the manufacture of pressed yeast; also those of malt making, beer brewing, and vinegar manufacture. These are industries involving botanical questions and belong to the department of physiological botany. The time is fast approaching when botany will be recognized by the biologists and chemists to its fullest extent and given credit for all its work. That this is already the case with the biologists, we need but to recall the recent discussions and examine the prospecti of some of our leading universities during the past year. In some of the "chemical" industries biologists (botanical biologists) are absolutely necessary for the production of good products. An object of special interest in the German exhibit was a pavilion of chocolate 30 feet high and made of 30,000 pounds of material!

The Japanese showed a spirit of enterprise which was possibly unsurpassed by any country or State. Rice was abundantly shown in all its varieties. The glutinous rice is chiefly consumed by making it into the form of cakes, called "Mochi." Upland rice or "Okato" is, generally speaking, far inferior in its taste when cooked to that of the ordinary rice grown in paddy fields, although there is but little difference between them in chemical composition. Many of the products of rice were exhibited. An interesting cultivated plant was Yegoma (Perilla ocimoides), which yielded 17 per cent. of a drying oil, which has the property, when mixed with other oils, that solidify in the cold easily (as rape seed), of preventing their freezing. The products of haze fruit and lacquer fruit were also shown.

Among fibers may be mentioned *Mao fiber*, the production of Boehmeria nilvea, and *Banana fiber*, the product of Musa basjoo. The fiber of Mao excels that of hemp by its flexibility, fineness and high luster. The finest quality is consumed in the weaving of costly cloth, which is highly esteemed by the Japanese for summer dresses. The poorer quality being used for making fishing nets, angling lines, etc.

Among barks used in paper making were exhibited the *Paper Mulberry* (Broussonetia papyrifera), *Mitsumata bark* (Edgeworthia papyrifera), and *Ganpi bark* (Wickstrœmia canescens). Specimens of raw and bleached bark with specimens of paper were exhibited. The Ganpi bark is valued especially in producing a smooth, fine, and high-lustered paper. Japanese paper is usually made from two or more raw materials, and is very seldom prepared from a single material. Moreover, the fiber of Ganpi and Mitsumata are not strong enough singly, yet they are extensively used with other coarse raw materials in order to give the tenderness, smoothness, and luster to paper of low quality.

Tobacco from nine prefectures was exhibited. The product of Kokubu is most highly esteemed by the Japanese. There were also exhibited some fine specimens of peppermint oil and menthol crystals. These products are yielded by Mentha arvensis, a plant cultivated from a very remote age in Japan. All the specimens exhibited came from the Yamagata prefecture, from which the exported products are also obtained.

In cultivating the plants the land is well prepared in the month of October, and the roots separated from the stubble are cut to lengths and planted in well-prepared soil in rows. In the next spring a dilute ordure is given the plants, when they grow vigorously. The first cutting is done in the middle of July, the second in the middle of September, and sometimes, but rarely, a third cutting is made in some districts. The plant is dried under a shed without exposing to the sun and carefully kept for future distilling. The best time for distilling is said to be the middle of January.

Among edible dried products of plants may be mentioned the dried sweet potato. For preparing this a certain quantity of cleanly washed potatoes are placed in a suitable basket and immersed in boiling water for a short time, then removed from the basket, cut into thin slices, spread over mats and exposed to the sun for two or three days. A superior quality is obtained by peeling off the skins before slicing. Other dried products were exhibited.

Summing up the products exhibited in this building, we mention that tobacco in all its forms was displayed with machines and appliances for curing it and manufacturing cigars, cigarettes and snuff, as well as insecticides and methods with appliances used to endeavor to stay the ravages of the tobacco worm and other parasites. Cotton on the stalk was shown in all its varieties; with methods of planting and cultivating, as well as the methods and machines used in picking, ginning and baling it. Likewise hemp, flax, jute, ramie and other vegetable fibers were displayed in their primitive forms and in all stages of spinning. Malt liquors with machinery and processes employed in fermenting, distilling, bottling and storing these beverages. Models of breweries in operation. Among vegetable oils were cotton seed, olive, rape seed, linseed, palm, etc., with the seeds and seed cakes as residues. Starches were exhibited with processes of manufacture from all sources, from cereals, tubers, arrowroot, plantain, cassava, zamia, manioca, tapioca, sago, pearl, flour, etc. Sugar cane, beet root and sorghum were exhibited in the raw and natural condition with the processes which finally yielded the commercial sirups and sugars. Sugars from palms, maple and milk were exhibited. To the agriculturist the different State exhibits were of interest, as the hives with the many varieties of Apis mellifica were displayed with all the modern appliances in the production of honey and wax. Some of the fertilizers of fossil and animal origin were of some degree of interest and of great importance. The exhibits of food stuffs were displayed in many instances in a striking manner.

The seed displays were divided between the Horticultural and Agricultural buildings. In the latter the field seeds were supposed to be shown to the greater or less exclusion of the garden seeds. The display of a firm of Paris (Vilmorin-Andrieux et Cie.), in the French section, was in the nature of a well ordered botanical museum. On the walls were hung panels of wheat, specimen charts showing the sugar yield of beets and the starch yield of potatoes, and illustrations of their farms. They had fourteen glass cases with models or casts of representative types of vegetables and strawberries. With the exception of a small collection of photographs in the alcoves of the Experimental Stations Exhibit, here seemed to be the only attempt to show anything of the results of hybridization. The name of Vilmorin has long been connected with experiments on the crossing of wheats, and some of the graphic results were shown in small sheaves mounted upon tastefully framed green felt. Here were exhibited, also, models of representative average and normal forms of vegetables. The prime value of these models with their excellent arrangement was that it afforded the student a means fixing the conventional standard or type and illustrating the chief lines of development and variation as arising therefrom. Two of the specimen charts were unique. One comprised six glass tubes about an inch in diameter and five feet long, containing proportionate amounts of "sugar in the juice" and refined sugar in the leading sugar beets. A similar chart displayed the starch yield from the varieties of potatoes. Altogether the exhibit was just such a one as a teacher of economic botany ought to possess in his museum and use in his teachings.

The Japanese garden was considered the unique feature, and has been acknowledged as a good example of Japanese art. It was $22 \times 141$ feet in extent and comprised 2,000 distinct plants. It was intended to represent such a garden as is to be seen adjacent to a dwelling house. Here were the hillocks, the cascades, the stone lamps, the sheet of water and the summer houses hidden in the clump of trees. Upon either side of the central walk were a miscellaneous collection of plants, so thickly planted as to nearly hide the earth. This walk passed over an arched bridge, which was peculiar in its construction. In the rear were blue and green sprays of Juniperus littoralis projecting over the water, while in front were large and small azaleas, ferns and red-berried adrisias. Among some of the interesting plants from Japan was a Thuja orientalis, about 3 feet high and 8 inches thick at the base. It was reported to be 100 years old, but its growth was so curtailed and dwarfed that it appeared as a very small shrub. In order to produce this result, the limbs of the trees are tied with ligatures, and at the same time they are placed in such positions that they will grow into the most fantastic shapes imaginable. The result is we have some trees reduced in size and presenting almost as hideous an appearance, compared to the original, as would a human being whose limbs and body were dwarfed, tortured and twisted out of all shape. A number of the genera were thus represented. One cypress, reputed to be 300 years old, perished with the cold of the previous winter. Some of the ancient crooked maples were but a foot high, in some of which every leaf had been carefully trained and others bore several varieties on the same top. A pine tree was exhibited with gnarled branches and massive roots. In some of the pines the needles were held in place to produce a fine cushiony effect that is so highly prized.

The azaleas exhibited were of much interest. The most striking ones were large and free-growing bushes of Azalea indica, which earlier bore single dull red and pink flowers. One variety in particular, called Mitsusomekuruma, attracted considerable attention on account of its very small greenish white flowers. There were exhibited also several varieties of the Ghent type. Here were two exceedingly curious forms reduced to five separate and long strap-shaped divisions. In one instance of the mollis type, the petals were red and spotted and the stamens were wanting. Another of the Indica type possessed dull pink or red petals and long red filaments entirely barren of anthers, giving the flower a strange, spidery look.

Proceeding to the viticultural displays, we saw a most decorative sight, although there was but little genuine horticulture in it. In considering the grape interests, it would be well to divide the subject into two parts, as the Italians and some others have done:

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viticulture or grape growing and viniculture or wine making. Viticulture was shown by illustrations of the vine and its varieties in natural and artificial ways by cuttings, engravings and photographs. Methods of planting, staking and training the vine were to be observed, as well as the methods of and appliances for cultivating, harvesting, curing, packing and shipping the grapes. On the other hand, viniculture was demonstrated by the methods employed in expressing the juice of the grape; of fermenting, storing, racking and bottling, and finally shipping the wine.

The Deutsche Wein Austellung contained a larger variety of hands and number of exhibitors than that of any other wine exhibition in the Exposition. The German Wine building was built in the form of a cloister cellar. The interior space being occupied with tables and stands of wine in bottles, being the combined exhibition of 289 growers and dealers of the German empire. The arrangement wae simple, but the chief attraction lay beyond, upon the eastern and southern walls. Upon these sides, in the form of panorama, some of the most striking of the wine regions of Germany were depicted. One looked as from a porch upon a landscape of remarkable picturesqueness, and the effect was greatly heightened by the plantations of grapevines in the foreground. These grapevines were the actual plants brought from the neighborhoods represented upon canvas and set in the earth as they customarily grow. Of course the vines themselves were not living, but were, however, dexterously clothed with artificial leaves and fruits, so that they almost perfectly represented the growing and bearing vine. As each of the panoramas represented a distinct wine district, so the wines in each of the foregrounds showed the exact method of training employed in those districts, and the artificial fruits and leaves represented the varieties grown there. There were many panoramas in the exposition, and there were none more perfect, nor probably more interesting (unless it was that in the Electrical building), than these of the German Wine building.

California's exhibit occupied nearly one-fourth of the ground floor space of this department. It was certainly with a feeling of pride that we viewed the efforts and progress of this comparatively young industry in the United States. One of the most notable pavilions was erected by four companies of wine producers. It was constructed of a section of a giant sequoia, which was 30 feet in diameter at the base and 290 feet high. Growing up from the base of the tree were grapevines, with an abundance of ripe fruit hanging from the vines. In the interior were the exhibits of the four prominent houses. The exhibit of the vineyard of the late Senator Stanford showed, in a perspective view, the natural size of a section of the cellars of the vineyard, which have a storage capacity of 5,000,000 gallons. This vineyard is probably the largest in the world, containing 3,840 acres, and producing annually 16,000 tons of grapes. Besides the exhibits of 25 smaller firms, the State Board of Viticulture had an instructive exhibit of photographs, engravings, etc., showing methods of cultivation of vine, etc.

The Japanese had a small exhibit. One sample of wine called "Seijyunbudosyn" was labeled with the following: "This wine can be recommended, as nothing equals it under the sun." The Italians were represented by 130 firms displaying 560 brands of wine, the oldest vintage of record being that of 1812. The Russian Imperial Appanages exhibited a model of one of the principal wine cellars of an estate in the Caucasus with a capacity of about 432,000 gallons. There were some interesting exhibits by a number of exhibitors of woods, herbarium and seed specimens, with photographs of the grapes and in some cases a display of the grapes themselves. Vitis Lincecumii, Buckley, and its hybrids, seemed to attract some attention as being a source of fine quality of grape.

Among the fruits, those of the citrus genus constituted one of the greatest attractions of the fair. The largest single exhibit consisted of a column thirty-five feet high, covered with nearly fourteen thousand oranges and some lemons. Lemon growing, while a comparatively recent industry in America, is looked upon as a paying product by the Californian people. The most remarkable as well as the most handsome lemon in the exhibit was the "Bonnie Bræ," shown in the display of San Diego. It was long and smooth and possessed a short tip, a thin skin, and was seedless. The fruit of Florida is earlier than that of California, but seems to keep better.

The lawns about the Horticultural building were well provided and represented by some of the products of the leading botanical gardens of the world. The original design of having them bloom in their season was wondrously carried out. During May the azaleas excited the admiration of the spectators, as their flames of color eclipsed that of all other plants flowering at that time. In early June 10,000 rhododendrons were the chief attraction. They are probably the most showy plant, and carry with them an air of massiveness and stability which makes them beautiful. During June and July some 50,000 roses, including over 2,000 varieties, were most conspicuous, and again "carried the day" and days. Was not this wonderfully suggestive? The roses of the world were here flowering at one and the same time, and saying, peace, my peace, our peace we give unto each other. Later came the cannas with their fiery plumes, and then followed the chrysanthemums and cosmos, the much prized and fashionable flowers of early spring. Besides these many other flowers were in bloom.

In the Manufactures and Liberal Arts building were a number of botanical exhibits. Of particular interest were the colored models and charts exhibited by Germany and Japan. The petrified wood specimens from the forests of Arizona were indeed large and beautiful. Ice coolers, fountains, mantels, table tops, and many ornaments were made therefrom. We were much interested in the ornamental application of the products of the Cactaceæ. It has recently been found that the cacti growing at different altitudes vary widely as to their general structure; that those, for instance, growing in high altitudes possess a finer grain than the same specimens growing in the valleys. The wood of the former being more compact and not so porous, has been found to be admirably adapted to the manufacture of a variety of ornamental articles. For manner of treatment of wood, etc., see SCIENTIFIC AMERICAN.

The exhibit of New South Wales was large and instructive. The Technological museum, under the direction of J. H. Maiden, having arranged every exhibit with full descriptions and applications. In this manner were displayed the economic plants, the substances used as food chiefly by the aborigines, gums, resins, and kinos from indigenous plants, tan barks, a miscellaneous collection of barks of economic value, indigenous fibers, galls, and specimens of Australian economic entomology.

There was also a case of fibers handsomely mounted, twenty fine illustrations, ten by twelve inches, very faithfully colored, from a forthcoming work on North American fleshy fungi, by Farlow, and a set of the published writings of Dr. Gray.

In the department of pharmacognosy the Pharmacy Department of the University of Michigan was the only institution that endeavored to show to the world the work she was doing. I was much impressed with her display of herbarium specimens of plants in connection with commercial samples of the various parts employed in medicine. In a similar manner were displayed many of our prominent plant drugs, as rheum, kola, mate, guarana, tea, coffee, guaiac, cubebs, nux vomica, ignatia, etc., with their chemical constituents. A capital "kindergarten" idea for a student's museum.

Coming to the State buildings, we find that many of them were not erected for exhibition purposes, but simply a kind of a club house, for the use of both men and women. Some few, however, were exceedingly energetic, and their displays were not only interesting but instructive. Illinois being, in a sense, the host of the Exposition, had by far the most portentous structure. It was constructed almost entirely of the products of Illinois. The agricultural exhibit was very large. Upon one of the walls was a most ingenious work of art. It consisted of a typical farm scene, with houses, animals, fields, crops, workmen, etc., made from the products of the State. The whole gives the idea of an oil painting, so perfectly had the blending of colors from the natural grains and grasses been made. Upon one side of the frame was a heavy drapery, giving the effect of silk, it also being made of different grasses.

The exhibition relating to botany was probably the most complete exhibit illustrating the teaching of botany to be found at the Exposition. There was to be found a working desk equipped for an undergraduate student and another for an advanced investigator; also a series of microscopes formerly used in contrast with those now used; also sets of permanent mounts, reagents, and stains employed, apparatus for photomicrography with photomicrographic enlargements, a very full bacteriological outfit with living cultures, an herbarium, etc. The Experiment Station exhibited a long case showing the diseases of cultivated plants and a collection of seeds of wild plants. Outside of the university exhibit there was a pavilion constructed of all the different woods grown in the State. Inside were samples illustrating the varied uses to which the various woods are put. There was another pavilion constructed of the products of the corn. The very uprights were grown in a cornfield, the roof being a thatch of stalks. All the decorations are typical of corn; the silky tassels served for frieze and dado, while the corn in the ear was arranged according to combinations of colors into many fantastic designs.

The State of Washington made a creditable exhibit. In front of the building was a mast, being a straight piece of fir, 3 ⅛ feet in diameter at the base and 215 feet high. The south and north wings each rested upon one piece of timber, 3 by 3½ feet and 125 feet long. Each of these pieces was cut from a yellow fir tree 7 feet 11 inches in diameter and 340 feet high. There was a life size full length of Washington, which had a frame made entirely of small pieces of wood, being inlaid with seventy-seven different kinds of wood found in the State. Besides an interesting agricultural exhibit, there was one of the best herbaria to be found in the Exposition, in that the collector had given considerable information upon the labels regarding the occurrence of the species exhibited.

To the systematic botanist, the herbarium specimens, illustrative of the flora of Minnesota, Colorado, Montana, Missouri, Kentucky, Wisconsin, etc., were of considerable interest. In the construction of their buildings and in their displays the Western States, more particularly the younger States, realized that this was their opportunity of making known to the world their individual natural resources. They endeavored to, and succeeded well in many instances in so arranging their products that it would strike the heart of the home seeker of limited means and the pocketbook of the capitalist seeking fields for the investment of his superabundance. Before closing this part of the description of the Exposition, reference should be made to the excellent collection of cacti in the Territorial (Arizona, Oklahoma, and New Mexico) building. Here was a Cereus giganteus or "Sahura," as it is called, some fifteen feet high, possessing a cristate top some four feet broad. Coming to that of Ceylon, we learn that her "courts" were constructed entirely of native wood. Here was the principal exhibit of her tea, and much valuable information could be obtained from the publication of Ceylon and from the attendants. In the Merck building were thirty-six wax models of medicinal plants. A number of specimens of opium, with scarificators and knives employed in obtaining the gum. Even in Midway Plaisance were some things of botanical interest to be found. Here the groves of orange and lemon trees, the Samoan houses, and the Javanese village.

In conclusion, we referred to the momentary inspiration upon seeing that magnificent collection of buildings at the Columbian Exposition as being akin to that when beholding a young man upon his commencement day—surrounded by the rainbow of promise. This Exposition which we have seen was really but the repetition of a commencement day's experience. We long before anticipated a supreme pleasure as we thought of going from one exhibit to another, collecting data and securing information from every available source of the world upon botanical matters. In this we had a similar experience and disappointment to J. C. Arthur, of Purdue University, who wrote (*Botanical Gazette*, September, 1893) that "there is considerable material through the Exposition of interest to botanists, but it is so widely separated and, in the main, so difficult to find that it is likely to be largely missed by those who would receive the most benefit from the display." Also, "very few of the exhibits are accompanied by adequate information, sometimes they are entirely unlabeled, and, as a rule, the attendants, if they can be found, can add little, if anything." This was to be expected, perhaps, in that the Exposition was a general exhibition. The managers, certainly, of the botanical part evidently did not appreciate the details nor impress others with the possibilities that were here presented for a most remarkable and unprecedented educational exhibit of scientific methods and results. Here, as in so many other cases, the evil was increased by the perversion of the public taste, which causes works to be admired, not in proportion to their fitness for their purposes or the skill evinced in attaining that fitness, but in proportion to their size and cost.

The last quarter of this century has witnessed a most remarkable development of specialization of labor. With the death of Mr. Darwin, we might say, was the extinguishment of the last scientific light that was able to illuminate equally well any and all departments of science. And, as for the affairs of the world at large, it has been many centuries since we have had the men of whom it might be said, "They have mastered all the knowledge of this day." And so in this discussion of the botany of the World's Fair, while we criticise (for to discuss was to criticise) we do not belittle the efforts of these gentlemen, for, under the circumstances, we do not feel possibly that we ought to have expected of them more than we do of a student upon his commencement day.

We hope that this is the last of the great general world's fairs. They may be very interesting and of some profit (like the displays in our large stores during the holiday season) to the average mind, but they do not receive the support or the attention of the highest intellects in the contribution of their best work. And this best work in every department where skill is demanded will at the same time do the average person infinitely more good (just as a college education) than the showy and often tastily executed exhibits of a general nature, attended with simply one's own interpretation, are largely intended as a means of commercial advertising. It is not my purpose at this meeting to expand upon this subject, but suffice it to say that we believe there should be in the future expositions having more a *specific character*. In the exposition of a scientific nature there should be a council composed of the most renowned and most capable scientific men, who should be given sufficient time and who should have the same means at their disposal as this Exposition committee for securing the contributions and support of the best institutions, societies, and individuals of the world. Furthermore, these exhibitions should be periodic and yet, in a certain sense, made as permanent as possible, so that additions and corrections should be made (similar to the committee of the U. S. P.) We are aware of many objections that may be raised, but these, in time, after reflection, might, too, vanish like the stagnant pools and marshes in the suburbs of Chicago upon which the White City was built.

By way of further suggestion, let us see what a world's botanical exposition might contain. One building might be devoted to the interests of morphological and systematic botany. Here could be displayed the models, charts, and methods illustrating the study of morphology. Also the different methods of collecting, drying, preserving and classifying plants. Laboratories might be equipped and work shown with information thereupon given. A similar exhibit might be made in the building devoted to anatomical and physiological botany. In the building devoted to medical botany, an exhibition (as interesting as that in the Manufactures and Liberal Arts building might be made), consisting of panoramas and illustrations of the cultivation, collection, preparation, with specimens, etc., of our important and interesting vegetable drugs. There would be other buildings illustrating horticulture, arboriculture, viticulture, viniculture, agriculture, geographical and fossil botany, as well as the other industrial, ornamental, and economical sides of botany.

It must be apparent that an exposition of this kind, botanically, would be, if properly managed, of a highly instructive and most interesting character to the world. The name of some one or of some event of world-wide importance would be necessary to arouse the interest in such an exposition. Might not the name of Linnæus do this? Is it too much to hope that the next world's exposition might be a botanical exhibition and called the World's Linnæan Exposition, to be held beginning May 23, 2007, in honor of the third centennial anniversary of the birth of Linnæus?

## DEVELOPMENT OF MINERALOGY—III.

By L. P. GRATACAP.

THE Arabians fostered learning, and from the East invaded occidental Europe with the heritage of Grecian speculation. They became the schoolmen of the continent, and enlightened the Christian schools in the rudiments and methods of astronomical and medical science. Their zeal in philosophy, their spirit of aquisitive curiosity and their keen application, soon gave distinction to their academies, and extended the influence of them far beyond the limits of the Moslem realm. Among these Avicenna (Ibn Sina), born in 980, and dying in 1037, contributed to the expansion of mineralogical science, or at least kept alive the interest in scientific studies from which, in its general aspects, mineralogy received a subordinate return. He was an Arabian physician, learned in the books of his time, in Aristotle, Euclid, Ptolemy, Galen, and animated by that thirst for knowledge which then appeared so strenuous among the Arabians. It impelled him and his great successor, Averrhoes, to traverse the field of human knowledge as then developed, and envelop their own speculations in the dress of that pseudo-scientific pretense to system which was the heritage of science from the classical period. At twenty-one he prepared an encyclopedia in which was reproduced all that he had read. His works are mostly medical, but there appears in them references to natural objects, and as many of the ordinary oxides were themselves useful in medicine, some narration may be found in his books concerning their localities and prop-

erties ("De Tinctura Metallorum, Declaratio Lapidis Physici").

In his "Conglutinatione Lapidum" geological science in some of its most prominent principles receives a singularly perspicuous definition, as in the origin of mountains, and the influence of aqueous erosion and deposition.

Averrhoes (Ibn Raschd) was born in 1120 and died in 1198. He exceeded in intellect his predecessor, and displayed a broader philosophical temperament, without as much acuteness of perception. He was deeply versed in Aristotle, and prepared an elaborate commentary and abridgment of the great pagan thinker. In "De Substantia Orbis," he treated of the texture of the earth and gathered together the utterances of his predecessors. The contributions to the development of minerological science of these distinguished Arabians, whose fame perhaps very much exceeds their merit, was more felt in its temperamental than its positive character. They kept alive science and so facilitated the growth of observation and of the spirit and enthusiasm for natural investigation.

In the sixteenth century appeared at Lubec, and subsequently at Leipsic, the famous metrical essay on gems in Latin, by Bishop Marbodus, Bishop of Rennes, written in the eleventh century. This curious production, which incorporated the various picturesque legends which time, fancy, and superstition had associated with precious stones, was utterly devoid of scientific importance. The pages of Pliny supplied much of it, and the writings of Isidorus, Bishop of Seville, who, in 630, wrote on precious stones, were also poetically reproduced in its rather listless and mechanical lines. This poem claims an earlier origin in the work of Evax, King of Arabia, who wrote to the Emperor Nero on the subject of stones. their names, colors, localities, abundance, and potency. It certainly has considerable antiquarian interest, and embodies that childlike and wondering element of thought which invested, in those credulous days, every fable with importance and every object of value with magic. The writer ventures, in rather free doggerel translation, to introduce the reader to some portions of this "Lapidarium," so far at least as to enable him to realize the mineralogical "point of view" of that early time.

Of jasper our melodious lapidary sings:

Ten and seven species of jasper are found,
Differing in color all the world round;
Hither and thither over the earth.
The green and translucent are best in their birth;
Worn chastely, fevers and pestilence fly,
And women in childbirth are helped thereby.
'Tis believed to bring safety, and as it is writ,
Expels the black fancies which o'er the mind sit;
While furnished with silver, around it enframed,
'Tis most potent to help the sick and enchained.

Sapphire—whatever may have been exactly indicated by sapphirus—is thus distinguished for its abundant talismanic qualities:

Sapphire, of gems, most apt for royal eyes,
Gloriously shining, most like the azure skies,
Inferior to none, in virtues and in beauty,
Is called by many the Stone of the Systites;
Since mixed with Libyan sands in wild confusion
'Tis found, by driving waves on beaches in profusion;
Though that most sovereign which the Medians bear,
Which yet, opaque, should lesser honors share.
This stone by potent Nature well endowed
Is sacred called, and gem of gems allowed;
For still the human body young it keeps,
And he unbrokenly who wears it sleeps.
Envy it overcomes, and by no terror shaken
Bolts it unlocks, chains breaks, and prisoners awaken.
It soothes the gods, and brings response to prayer.
'Tis said, for reconciliation, good to hear.
And still more dear Cynthia loves this gem,
And grants to all who wear it her amen!
For corporeal ills this stone is ample cure,
The fever's flame its coldness cannot endure;
It brightens still the eyes, removes the ache
Of listless head, and mixed with milk, the ulcerous cake,
While stumbling tongue it helps to speak;
But he who wears it chaste must keep.

Two more examples from this unique work may suffice to gratify the curiosity of the reader or perhaps furnish him inducements strong enough to read the original poem, which, in spite of its utter dearth of sentiment, is curiously interesting. The first extract is a description of beryl, in which at the outset its six-sided (hexagonal) form is alluded to, and the second refers to the tradition of the glacial origin of quartz, with an expressed doubt whether this time-honored inference is unexceptionally true.

Conspicuous the six-angled stem reveals
The beryl; which, unless colorless, conceals
A violet tint, or else the sea-green wave
Seems shining there, as seen within a cave.
This stone from India comes, a token,
'Tis said to help the love of married men.
Though they that wear it fall to boasting,
And tightly squeezed the hand seems roasting.
The water that laves its sides wherein it lies
Will bring refreshment to ailing eyes.
Or drunk, will quickly all the lungs renew
And cure the troubles of the liver too.

The lines devoted to quartz (*crystallum*) are as follows:

The crystal hardened by long-enduring cold,
As some have written, others sagely told,
Still to our eye reflects the color of the ice,
Though this is doubted as a fact precise.
Since, so they say, in warmer climates too,
The crystal rock with equal beauty grew,
Yet this is fixed, nor mixed with doubt,
That when against the sun 'tis turned about,
It conjures fire, and dry weeds enflames,
This is most clear, and chief among its claims;
And also mixed with honey by matrons used.
The breasts with milk are then suffused.

For the most part, this celebrated poem confines its treatment, as might be expected, to those associations with gems and valuable stones which recall their virtues in sickness, or peculiar subtile emanations, whose efficacy their owners derived from wearing them. Many stones are mentioned whose identification is extremely doubtful or impossible, as the *Galactida*, the Medean stone, *Chelonitis*, *Orites*, *Hyaenia*, *Enydros*, *Pantheron*, *Apistos*, and others; obscure mineralogical aggregates, or stones perhaps, which in some cases obtained distinction from their water-polished surfaces or chance brilliant coloration.

In the twelfth century Mohammed ben Mansur prepared an elaborate treatise on stones in which his own observations were plentifully incorporated. This was followed by the writings of Albertus Magnus, who living in the thirteenth and fourteenth centuries, first insisted on the importance of form and began those speculations as to the origin and essential substance of minerals which brought him into reflections upon the crystalline condition and fixed constitution of mineral species. He wrote ("De Mineralibus et Rebus Metallicis") "it is therefore certain that stones (minerals) have fixed forms and species. These forms are not spirits, for life is essential to spirit. If they make use of nourishment, they should be provided with porous avenues through which such nourishment might be merged, assimilated in them. Neither is it conveniently considered, since the spirit of a stone may then be oppressed by terrestrial inclosure, and thus unable to exercise life and sense, as many physiologists aver, since their nature would be deficient in necessary parts by not giving organs to stones, by which she should expedite their necessary operations. Stones therefore have not spirits, *but they have substantial forms endowed with celestial virtues and a commixture of proper elements.*"

Here we discern the glimmering or awakening of thought in relation to the nature of minerals. They were no longer inorganic groups of physical qualities, accidents of location, or partial reflections of human definitions. Their interior state, the individualizing power, influence, or constitution which they represented, began to force itself upon speculative minds, and so dawned the metaphysical era of mineralogical science which, in conjunction with the growing popularity of alchemy, retained the science in a quasi-grotesque phase of poetical and chimerical invention.

The ripening spirit of scientific investigation received a fresh impulse from the enthusiasm and learning of George Agricola in the sixteenth century. He was a man of marvelous acquisitions. All the knowledge of his time, all the inherited wisdom of previous ages, with their speculations and vagaries of thought, were known to him. He was finally a critical mind. He weighed carefully his conclusions, and so became the real pioneer in the creation of a mineralogical science which began to reveal some of the features which characterize it to-day. E. Lehman, his translator, says of him: "He was the first in modern times who reflected upon mineralogical subjects with perseverance, unprejudiced judgment, and fairness, and wrote with Grecian elegance." He discussed the geognostic problem of the earth's surface, the character, nature, and processes of volcanic action, the features of fossils, the circulation of the atmosphere. He studied the movement of water, its geological and chemical activity, its physical properties; he wrote upon air and heat, the currents of the air, their causes, upon earthquakes, their kinds, upon the heat and volcanic fires of the earth, upon the origin of mountains, upon mining and peculiarities and changes in fissures, vein matter, etc., upon mineral earths in their general relations, their origin and character, upon the features of stones, their formation and their physical features. He brought into notice, in this relation, besides the color, taste, odor, luster, hardness and transparency of minerals, their density and gravity, their roughness and smoothness, etc. His treatment of these subjects is somewhat pedantic and scholastic. He introduces a subject, as water, gives some proposed explanation of its occurrence, accompanied by proofs, these in turn he overthrows, then follows a second interpretation of the phenomenon, considered with new arguments for its support, which are, in turn, destroyed; the series of alternating propositions with their appropriate discomfiture being concluded by his own hypothesis, which naturally remains unchanged, *nem. contrad.*

He adopted the division of the four principal elements in minerals as the earthy, saline, ignitable and metalliferous. The term fossil expressed all the mineral contents of the earth's crust, without reference to their organic origin. He separated these mineral sections into groups; as under earthy, the siliceous, argillaceous, barite-bearing, talc-bearing, calcareous; under the saline, cooking salts, sulphur salts, etc.; under the ignitable, coal, graphite, bitumen, etc.; under the metallic, the argentiferous, auriferous, etc. These divisions were again broken up into subordinate generic (specific) heads; as under the siliceous he placed quartz, flint, which again received a varietal analysis, as under quartz he placed rock crystal, prase, chalcedony, amethyst, while again, according to their quality (Sippschaft), these varieties are still further dissected, as in amethyst, the common and dense.

Here was classification enough to satisfy the systematist. Already the chemical initiative, introduced through alchemy, had revealed the chemical character of many compounds; mineral species had increased, and we begin to recognize in the pages of Agricola the growing complexity and expansion of the science and its widening nomenclature.

Agricola had noticed the varying crystalline forms of minerals, how many possessed angles, some had triangular faces, others were cubic, as pyrite, while the modifying secondary planes about the terminal pyramids of quartz excited his wonder. He averred that minerals, especially crystals, had been formed from a pure liquid solution.

Hieronymus Cardanus in 1663 wrote upon the nature and forms of minerals, especially of gems. It was gems whose conspicuous beauty, distinctions in color, and crystalline individuality from the first attracted attention and afforded grounds for speculation. Cardanus wondered over the six-sided form of quartz (crystallus). He suggested that it might have arisen, as did the hexagonal form of the bee's cell, from the surrounding and reciprocal pressure of spheres, but abandoned this physical explanation and assumed an implanted force which expressed itself in length and breadth and depth in such a way as to give six sides to quartz, and related hexagonal minerals as beryl, a view which was ridiculed by his opponent Scaliger. Christopher Eucelius continued the publication of observations upon the mineral contents of the earth which he had seen, and, as with Agricola, made most of his notes upon the minerals of mining regions It was the industry of mining which in the rise of German mineralogy played an important part in eliciting the attention of students of nature for the inorganic products of the recesses of the earth. Eucelius noticed the regularity and persistency of crystals, and expressed his admiration of the activity of nature in the depths of the earth (*Adeo non ociosa est natura, ipsis in terrae visceribus, ipsis in tenebris*) where "she displayed her geometrical power" in these crystallized masses, and where too, as he says, he had seen the impressions of little fishes, and the "traces of lions and wolves."

Crystallography in its adaptation to the study of natural forms received an important impulse from Wentzel Jamitzer, who prepared 140 models of geometrical forms, in which the simple forms were abundantly modified and were grouped in composite multiples, so as to suggest twinning and trilling. Caesalpinus, Gesner, Kentman, living at the end of the sixteenth and beginning of the seventeenth centuries, attempted to reveal the secret of crystallization. The first artificially prepared alum, saltpeter and sugar crystals, and said of quartz, which from its universality and perfect crystallization challenged attention, that it had been formed from the purest substance, and so in its six-sided form more nearly approached the circle, which might be regarded as the perfection of form and most expressive of the purest liquids. He imagined the terminal pyramid of quartz was produced by deficiency of material for the continuation of the prismatic faces, and that it was more clear and less contaminated than the rest of the crystal, in which, as it were, the dregs of the solution settled. Gesner pointed out irregularities in the angles and faces of quartz, and Kentman observed and described natural crystals.

Peter von Arles imparted some of the mediæval romanticism to his conceptions when he assumed, at the beginning of the seventeenth century, a correspondence between the seven metals, the seven precious stones and the seven planets. The moon symbolized silver and quartz. Of the form of quartz, he speculated as follows: "When the earthy and supernatural matter separates itself from water, it (the matter) struggles in every part to consolidate itself, and lines (radii), as if drawn from some central point, appear to shoot outward toward the circumference. But, as they (the lines) meet opposing lines, they cannot complete a circle, but only (through peripheral impact) form a six-sided figure." (*Sympathia septem metallorum ac septem selectorum lapidum ad planetas.*)

The distinguished Anselmus Boetius de Boot wrote in his "History of Gems and Stones" that the formative principle in minerals was a lapidifying power. Matter separated from solution through withdrawal of heat was drawn into angular shapes, and stones which increase through growth, as crystals, possess a force not dissimilar to that of plants, whereby they are formed. The six-sided form of quartz he believed inexplicable or to be referred to such causes as give peculiar shaped leaves and flowers to plants. Paracelsus preceded Peter von Arles in the vagaries of imagination which connected the metals and minerals with the seven planets and neighboring stars. These metals and minerals ejected from these distant orbs had fallen on the earth, but the quartzes, beryls and citrine had been "coagulated" in the "snow stars." These oddities and mystifying fancies were reflected in the writings of Baptista van Helmont, which involved fabulous and metaphysical explanations, the crude substitute for more radical knowledge which was then unattainable. He, however, contested Paracelsus' assertion, the time-honored fancy of the Greeks, that quartz was an obdurate, irreducible ice, saying it was opposed to the essence of life that one thing should pass into another by an exterior influence, viz., that snow by cold should become crystal. Since he further avers everything has its seed, beginning (Archeus), from which it ever new arises and by which it receives its form, that, on account of special seed or germs (*propter specialia semina*), stones received their configuration, not less constantly and regularly than the breeds of animals.

Crystallography received a veritable contribution in the mathematical dissertations of Johannes Kepler, who took five geometrical solids and evolved from them a series of forms, related and interdependent, of which many are exactly reproduced in nature. The Jesuit philosopher, Athanasius Kircher, attacked anew the ever-present problem of crystalline forms, and, like so many of his predecessors, fixed his eyes on the enigmatical six-sided, pyramid-terminated quartz. He asserted that it derived its form from the peculiar endowments of the salt composing it, that in all salts a force moved their particles outward from a center along four, five, or more lines, and so four, five, or six sided figures were created, the interlinear spaces being filled up by inrushing particles brought thither by a certain magnetic impulse.

Erasmus Bartholin, a distinguished mathematician, encountered the then newly discovered transparent (1670) Iceland spar. He measured its angles, found out their permanency, even in the smallest cleavage fragments, dissolved it in acids, examined its colors, and with astonishment recorded its power of producing duplicate images (double refraction). Huygens examined with the greatest care this phenomenon of double refraction, and so exhaustively followed up its laws as to leave little for subsequent investigation. He also detected double refraction in quartz. He anticipated some modern molecular theories, in his suggestion that calc-spar (calcite) was made up of ultimate ellipsoids, heaped up in such a way as to form rhombohedral pyramids, and that the points of their consecutive contact along certain planes, parallel to the rhombohedral faces, formed surfaces of easy cleavage.

The microscope, which had been invented by Zacharias Jansens about 1590, had been improved, and began to play an important role in the advances made by natural science in every direction. Leeuwenhoek adapted it in an original way to mineralogical research, and revealed the minute crystallization of minerals, and turned his attention to the forms of alum, carbonate of soda, saltpeter, sulphate of copper, Glauber's salt, and sal ammoniac. Isaac Newton calculated the thickness of the thinnest plates of mica and gypsum, the cleavage of which latter had awakened in Leeuwenhoek the liveliest admiration. It was indeed from his experiments upon the double refraction of light in calc-spar that led Newton to advance his theory of the four-sided nature of light and to oppose the theory of wave motion. Physics were making strides in the domain of mineralogy, dawning conceptions of crystalline regularity were making a way for the generalizations of Steno Romé de Lisle and Hauy, philosophical theories were realizing more fully the molecular forces playing in the substance of inorganic compounds; but chemistry had yet done little toward determining their constitution, and systematic mineralogy made unimportant progress, nor was to until the elements of chemical analysis, per-

fected a century later, were elaborated. Robert Boyle concludes this period of mineralogical development, following the division arranged by Dr. C. M. Marx in his work on the "History of Crystallography," which we have here in some parts almost literally presented ("Geschichte der Crystallkunde," von Dr. C. M. Marx, Carlsruhe und Baden, 1825).

Robert Boyle observed the geometric outlines of minerals, and made some observations upon the cavities in stones, lined with minute crystals formed, as he remarks, by a lapidifying juice (*succus lapidesceus*) of great purity. He also called attention to the lamellar texture of many minerals and made a long, patient series of notes and descriptions upon crystalline forms. The next stage of growth was now about to usher upon the science as known to men the profound and varied facts which built up crystallography, and laid in chemical composition the foundation of a rational system.

## INTERESTING DISCOVERIES OF EGYPTIAN RELICS.

THE discoveries made by the French Director of Excavations in Egypt, M. De Morgan, near one of two ancient brick pyramids not far from Cairo, are exciting the deepest interest in London and Paris, as well as among the tourists and European residents on the Nile. Brief allusions were made early in the month in the current news of the fine arts, but these finds are so important that further notice is necessary.

The tombs and presumably the brick pyramid (since bricks found in the subterranean tombs are like those of that monument itself) belong to kings and princesses of the twelfth dynasty.

Egyptologists have divided the dynasties of the Pharaohs into thirty and group the thirty into dynasties, 1 to 11, 12 to 19, and 20 to 30. This is merely for convenience, and was unknown to Herodotus, Manetho, Josephus and others who have written about the early kings. Nor did the Egyptians themselves have any such system. From the first group (1 to 11) we have only the slenderest details and no jewelry or gold ornaments. Indeed, it is not till we reach the eighteenth that we get in our museums and that of Egypt certain objects that belong to the minor arts of personal decoration and so forth. The excitement that M. De Morgan's find has aroused is therefore natural; for here are art works of very great beauty from the tombs of at least three Pharaohs—Usertsen II. and III. and Amen-em-hat III., whose reigns are placed by Mariette between 2366 and 2300 B. C., or about 4,000 years ago.

Concerning Usertsen II. we know that a Semitic tribe called the Aamu came from a country named Absha with tribute. Concerning Usertsen III. we are told by the inscriptions that he made a great campaign up the Nile against the black Nubians and built a temple at Elephantine. As to Amen-em-hat III., he is of even greater note, since it was he who built in the Fayum the great artificial reservoir for his people, which was called Lake Mœris, the site of which is still debated. He also built the labyrinth, said to have had 1,500 rooms above ground and 1,500 below. Lake Moeris stored up the water of the Nile during the season of floods, and was tapped in the dry season as required.

Herodotus has a quaint story picked up in Egypt about 450 B. C., which may relate to one of the brick pyramids at Dashur, concerning a king of the unrecognizable name Asychis. He wrote on a piece of stone the following apology: "Do not disparage my worth by comparing me to those pyramids composed of stone. I am as much superior to them as Jove is superior to the rest of the deities. For, thrusting poles down into the lake, and collecting the mud deposited on the poles, bricks were fashioned, and in this manner was I made." The meaning of which may possibly be that, in the opinion of the king, or of the Egyptian who told Herodotus this particular yarn, it was more honorable to a pyramid to be built of the fertile mud of the Nile than the dead stone of the desert.

Humility like this seems to have failed to put the grave robber off the scent for funereal treasures, since the brick pyramid in question has been ruined in every direction, and is now only ninety feet high, a long mound of disintegrated, sun-dried brick, with its top a mere crater. Even the tombs at some distance were rifled long before Herodotus, yet the robbers either missed some of the spoil, or themselves proceeded to bury some with the intention of returning at a better moment. Some side chapels, or niches, were found still walled up, but the richest treasures were discovered several feet under the floor of a gallery strewn with skulls, broken or empty boxes, and fragments of sarcophagi.

M. De Morgan must be credited with a good deal of sagacity in this discovery. He is the third important director of excavations in Egypt since Napoleon III. lent Mariette to the Egyptians. After Mariette came Maspero; after Maspero came Grebault; now it is his turn to uphold the honor of France in a field opened by Napoleon the Great a century ago. His excavations in the Caucasus for the French government some years ago prepared him for this work. Having selected the brick pyramid as a good site for very early tombs, he drove a shaft directly through its center to the bed rock without positive results. Then he moved to some distance and began sinking shafts, well knowing the efforts made by these kings to conceal their tombs. Finally, on Feb. 28, he struck an unimportant tomb. But the bricks were like those of the pyramid. He had found the radius. On March 2, his foreman reported a door of cut stone; breaking through that a low tortuous gallery was found heading toward the pyramid and ending in a tomb, with the remains of a sarcophagus and a statue carved in diorite, which robbers had broken up, perhaps thinking that they contained treasures concealed in the stone.

From the tomb Morgan worked into a long gallery running east and west, having on the north four doors of white limestone from Massarah, on the other, or east side of the Nile. These led into chambers cut in the bedrock and lined with Massarah cut stone. One has an elliptical vaulted ceiling formed of great blocks hollowed out. Here were broken sarcophagi of a king and queen, skulls, lamps, and broken tiling stones. Some granite boxes containing lamps had been left intact. Others were empty. By this time the air had become so foul that the lights began to dim; having found a walled place across the gallery, M. De Morgan withdrew, plotted out on the surface of the ground the place of that wall and set his men to dig.

Two days later the old shaft was struck which gave the needed ventilation. Below the grand east and west gallery he found a row of chambers, with eight sarcophagi and various empty granite coffers. He has made out the tombs of thirteen princes and princesses. On March 6, he found below the floor of a gallery the first treasure, with its box mouldered away and the jewelry mixed in earth and sand. On the 7th he found a second cache. How much more will be discovered no one can tell, but what we have is indeed a valuable addition to our knowledge of the artistic powers of the Egyptians long before the earliest date assigned by scholars to the Trojan war.

Among the gold finds are a crouching lion, cypresses of gold, a necklace of lion heads, bivalve shells of gold. A breast ornament bearing the cartouche of Amen-em-hat III. shows that king raising his battle ax to smite an Asiatic enemy, while he tramples a negro under foot. There are bronze and silver mirrors, heightened with gold, jewelry with amethysts, carnelians, lapis lazuli and Egyptian emeralds, vases of carnelian, obsidian and alabaster. The carving of some of these jewels, especially in the rings, is said to be marvelous. Examined with a glass, the human figures are seen to have every muscle correctly modeled. Necklaces, bracelets, chased and set with hard stones and pearls, are said to be marvels of beauty, surpassing all the work of later reigns, which are mere debased copies of these ancient ornaments. In texts the find is not rich; but few pyramids have yielded much in that line. In fine, M. De Morgan has signalized his advent to the responsible position he holds by a feat which is likely to remain one of the most brilliant in the history of Egyptology.

## A PHENOMENAL JUMPER.

AMONG the many unique features at Barnum & Bailey's show, which is now exhibiting at the Madison Square Garden, in this city, the jumping of Joseph Parker stands out as a conspicuous attraction. With half a dozen chairs, as many nine inch bricks, a pair of nine pound dumb bells, and a healthy-sized horse, Parker gives a series of exhibitions which rarely fail to command attention and applause.

The agile Englishman was born in Dudley, Worcestershire, thirty-two years ago, but subsequently moved to Tipton, which has been his headquarters for the past twenty years. In his street attire he looks too heavy for an athlete, and the modesty of his bearing adds to the deception. When stripped, however, a glance serves to convince the most casual observer that Parker's development is just what is needed for the branch of athletics to which he devotes himself. He stands 5 feet 6 inches tall. His legs are slightly bowed, owing to the abnormal development of the upper leg. He measures 26 inches around the thigh and 18 inches around the calf. He weighs in condition 174 pounds, but little of this is to be found around his waist, which is only 28 inches.

Parker measures 42 inches around the chest. His reach of arm is so phenomenal that when standing to attention the finger tips reach below the knee joint. He attributes most of his success to his expanse of chest and reach, as he can carry bells with impunity the weight of which would anchor a less robust jumper, while the extra leverage afforded by his length of arm heightens the effect of his efforts. He usually carries nine pound bells in his tricks, but when jumping for distance on special occasions, he uses much heavier weights.

Parker has been before the public for about four years, but only recently came to this country to fill the season's engagement with Barnum & Bailey. The limited time allowed for his act and the rival attractions being presented at the same time all over the arena have so far prevented many patrons of the great show from forming a thorough estimate of the Englishman's ability, but the aspiring young athletes fully appreciate his performance, and their favorite vantage point is on the Twenty-sixth street side of the garden, where they wait patiently for "Circus display No. 10." When this is ushered in a boarding is stretched on the floor between rings one and two, and Parker appears clad in skin-fitting gymnastic costume and heavy jumping pumps. A few of his many astonishing feats are as follows:

Jumping from the end of a brick over a chair on to another brick, thence over another chair to the third brick, and, finally, over a chair twelve feet away, without pausing between jumps or disturbing either chairs or bricks.

Jumping lengthwise over six chairs placed in line, without any impetus beyond two preliminary springs.

With ankles bound together, jumping over a cross bar 5 feet 6 inches from the ground.

The interest becomes absorbing when Parker changes his shoes for heelless slippers and steps on a brick to clear a horse at one bound. His ankles are then tied, but he leaps over a 15 hand horse without ruffling a hair on the neatly groomed equine. After his ankles are released another horse of greater height and girth is brought out. T e jumper poises himself carefully on the precarious footing afforded by the brick and clears the live obstacle in magnificent style, dropping the bells on the take-off side when he has projected himself to the necessary height. An attendant is then poised across the backs of two chairs Parker braces himself for a crowning effort, bounds on to the man's face and off again with such celerity and lightness that those not near enough to see the smudge left by the slipper generally miss the point of the trick.

Parker's admirers claim that he is without a peer at standing forward, standing backward, and standing high jumping.

Parker is a married man and the proud parent of a twelve year old daughter who has no equal at her age in her father's department of athletics. The Englishman never trains, in the old-fashioned sense of the word. He nourishes himself solidly and liberally, and his continuous engagements serve to keep him in condition. Like most Englishmen, he believes implicitly in good "grooming," and submits himself to a thorough rubbing every time he strips. His muscles are finely developed, and he has all the appearance of a man who has healthy propensities and lives up to his theories. He has a pronounced taste for running, but he does not over-indulge in the sport, for fear his jumping muscles might lose their flexibility. After his act at the Garden, however, he generally lets himself out a bit and sprints across the arena with the gait of a man who has learned to "hop the twig" at Sheffield.—*N. Y. Sun.*

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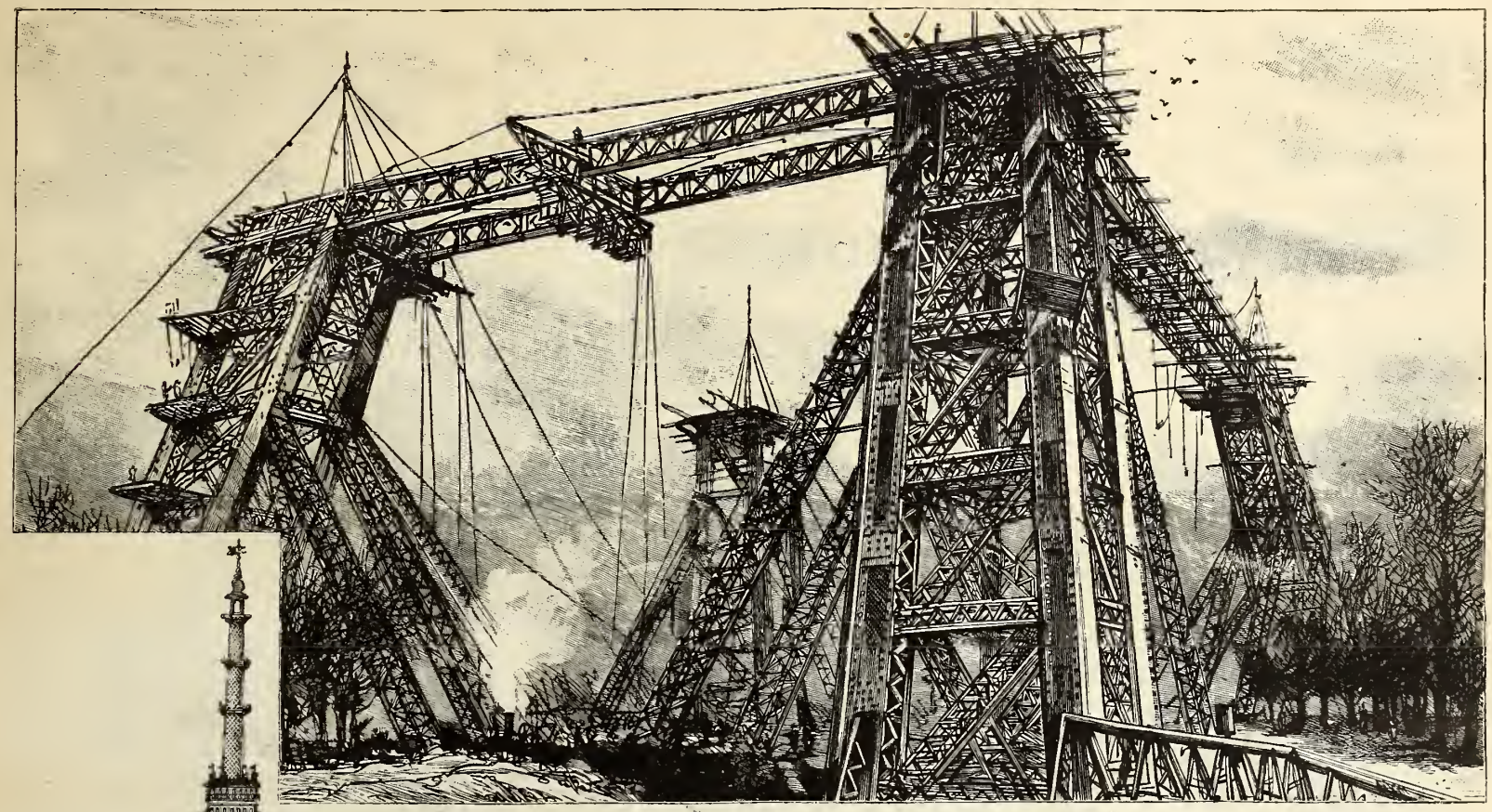

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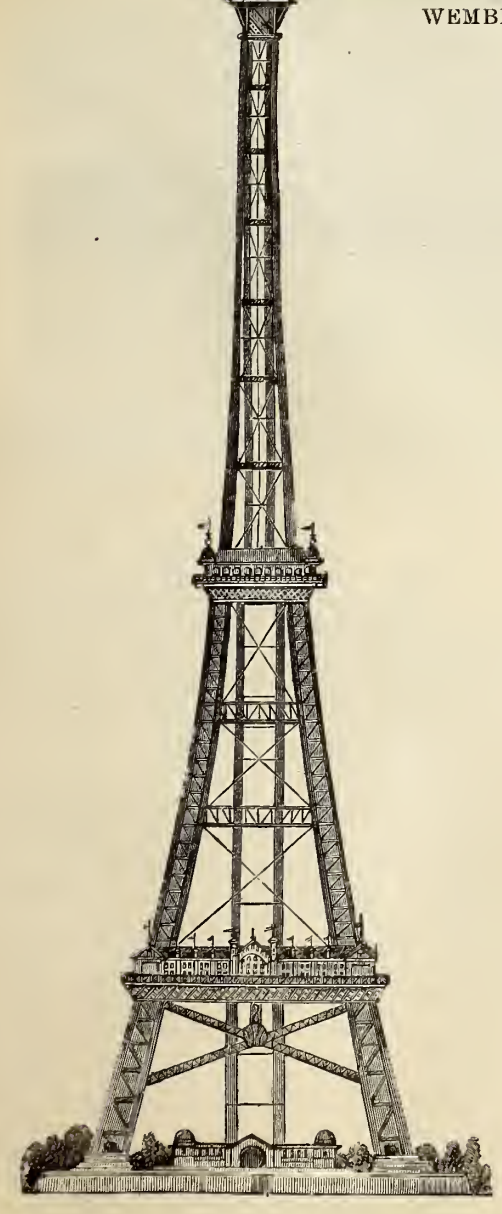


THE TOWER AT WEMBLEY AS IT WILL BE WHEN COMPLETE.

[From the Graphic, London.]

## THE GREAT TOWER AT WEMBLEY.

Wembley Park is now in a most attractive guise, and whoever goes to note the progress of the great Watkin Tower will certainly stay to admire its surroundings. One of the finest colonies of rooks near London are busy nesting in the trees in the park, and the early spring has covered the extensive landscape in view from the hill on which the tower is founded with a delicate green, broken here and there with masses of blossom. The Metropolitan Railway trains on their way to Aylesbury and Chesham rattle past, but do not disturb the quiet overmuch, and there is, when the men at the tower have gone to dinner and the hammering has ceased, the pleasant plashing of falling waters to be heard coming from the rivulet which hurries along the bottom of the park. This is from the little River Brent, which has been broadened out into a lake of eight acres. A couple of bridges have been built—one of the ornamental order, upon which sentimental pairs may linger and listen to the waterfall which is below it; the other is built for use, and over it the visitors will pass into the park. Boats are to be placed on the lake, and on one of its three little islands will be a small kiosk. The chief attraction, however, is the cricket and football ground, surrounded by a fine cinder path, which is the largest in the country, having only two laps to the mile, with a finishing stretch of 350 yards "on the straight." As for the park generally, it has been effectively laid out in curving pathways, with shrubberies and flower beds. The fine trees in the park have been preserved as far as possible. A little glade in the northeast corner at night will be lit up with fairy lamps, and concerts in the open air will be given in fine weather. About twenty thousand pounds have been laid out on the buildings in the park. They include restaurants, grand stands, a big shelter for wet weather, band stands, tea pagodas and pavilions. These are attractions enough apart from the tower, which is now rising toward the sky.

Over a hundred and fifty men are constantly employed in putting the tower together, and they are making rapid progress. The foundations have been down a long time, and have quite settled. The first stage is also practically completed, and already the tower is difficult to lose sight of when one is anywhere in the neighborhood of Harrow. Progress has been very steady, and there have been no delays by accidents, or any unforeseen difficulties to be met. The tower is designed by Mr. A. W. Stewart, but some of its details have been modified since Sir Benjamin Baker and Mr. Stewart took the work of erection in hand. Sir Edward Watkin secured the design, it should be said, in response to a prize he offered for such a tower. When the design was selected it had eight legs. These they have now reduced to four, but really the

THE EIFFEL TOWER.

base consists of four groups of four legs each, and each leg rests on its own concrete foundation. It is nearly two years since Messrs. Firbank put in the foundations. The building of the tower above foundation level is being done by Messrs. Heenan & Froude, of Manchester, who are not without experience in such work. They were the builders of the tower, 500 feet high, at Blackpool.

Mild steel is the material used for the mighty structure. We give two sketches which will enable the reader to understand how much higher the Watkin will be as compared with the Eiffel Tower at Paris. The tower will somewhat resemble the one at Paris, but the arrangement of lifts will be different. There will be four lifts. Two will ascend to the height of 150 feet only, and two will go up to 900 feet. They will be all independent, and will be driven by winding engines. At Wembley Park there is not the same necessity as at Paris to have an open space under the tower, so that vertical lifts can be used. These will travel more quickly than if they had to pass up one of the legs. There is the further advantage that the lift guides will stiffen the structure and help to support the first platform, thus enabling lighter girders to be used.

Details of such matters are rather dull reading, but to show what is involved in the erection of such a lofty structure we may give a description of a base. Each base piece weighs ten tons, and stands on a sole plate 9 feet by 7 feet 6 inches, and three-quarters inch thick. Then seven 12 inch by 6¼ inch joists three-quarters inch thick are riveted to the plate, and on these is another plate of the same dimensions. Joists have been let into the concrete on which the bases rest, so that, if necessary, they may be moved slightly for the purposes of adjustment. There might be a risk of the leg slipping bodily forward during erection. To prevent that the bottom sole plate has riveted to it a 4½ inch by 4½ inch angle of steel five-eighths of an inch thick. The base pieces are held in position by bolts 2½ inches in diameter, with a three inch thread and a length of thirteen feet. Above the brace pieces the legs are in 26 feet lengths braced together by cross and diagonal girders. Each of these sections weighs seven tons, and is constructed of plates 7-16ths of an inch in thickness. The angles are 4 inch by 4 inch of half-inch thickness of metal. The horizontal and diagonal bracing girders are square in section and connect the legs at every second length, at distances of 52 feet. The extreme width of the tower from outside to outside of the legs at the ground line is 406 feet. The heaviest pieces in the tower are now erected. Our artist has sketched one of them as it was prepared for lifting into place. It is one of the main girders at the first floor level, 146 feet from the ground. It weighed 40 tons, was 140 feet long, and was lifted in one piece. It should be said that all the material is brought to the site by railway, and lines run to each of the four legs. A steam winch has hitherto done all the raising with "shear legs" 65 feet high at each tower leg. The erection will be continued by means of four electric cranes. These weigh about 20 tons, and will run on special girders bolted by the side of and just above the horizontal struts. The cranes will unload direct from the railway trucks, and as each section is finished they will be able to lift themselves to the next level in twenty-five minutes. One central or generating dynamo will serve for all four cranes. It will only work one at a time, but will have sufficient spare power for some electric drills. After the tower reaches the height of 500 feet, only one of these cranes will be used. It will be provided with a longer jib, and will be in the center sliding between the lift guides. One figure more. When completed, the total weight of the tower is estimated at 7,000 tons!

The total height of the tower when completed will be 1,150 feet, that of the Eiffel Tower being 975 feet. The Watkin Tower stands on an eminence 165 feet above sea level, and at this tremendous height it is difficult to form an idea of the wide stretch of country which will be under foot and within sight. The lifts will carry 60,000 people a day. As for the uses to which the tower will be put some day depends on circumstances. On the first platform, which is 160 feet from the ground, and is about 200 feet square, shops, restaurants, side shows, and a concert hall will be built. The second platform will be at the altitude of 500 feet, and this will contain similar buildings to the lower platform, but on a smaller scale, as the space at command will be much less. Higher still a third platform will be built, and on this will be a post office, a telephone call office, and other small buildings. Right at the top will be an observatory and a very powerful electric light, from which the beams should be seen from great distances. That on the Eiffel has been seen seventy miles away. The tower is expected to be finished next year, and will cost £200,000.

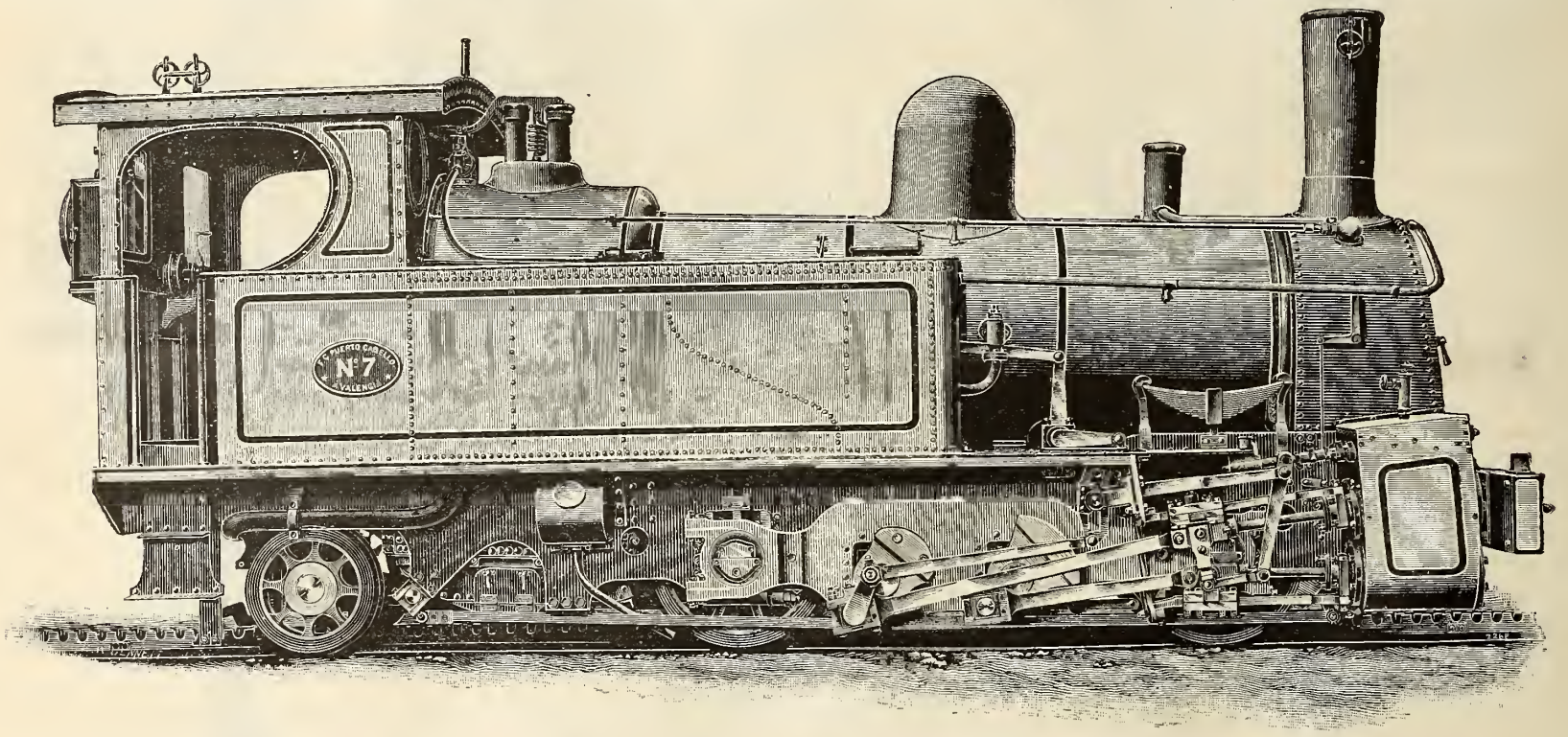
Interesting as the tower may be, a much prettier sight is the country round it. One is only six miles from Baker Street, yet the lanes leading to Harrow or to Kingsbury, with their wealth of trees, might be in some distant part of Kent. By the way, too, close to the park gate at Wembley, and actually on the property of the company, which is here appealed to to spare them, are three of the most picturesque cottages to be found anywhere about London. One of them serves as a lodge. Its roof is thatched, and it is covered with ivy, and it has attached a structure for containing beehives quite in the old-fashioned way. Almost adjoining the lodge is a still older-appearing cottage with gables and dormers. Immediately opposite is a partly half timbered farmhouse, almost concealed behind a luxuriant growth of ivy. Thus at Wembley you may contrast the structures which contented our forefathers and those which but ill content us. For who will say the Watkin Tower is final?

## IMPROVED RACK LOCOMOTIVE.

IN a paper read some time back before the Institution of Civil Engineers on the Puerto Cabello and Valencia Railway (Trincheras Incline) by Mr. J. Carruthers, M.I.C.E., a short description was given of the locomotives designed for use on the incline. Ample experience of the working of these engines during the last six years having been obtained, it may be of interest to give leading particulars of their design, the amount of work they are doing, and cost of haulage. The engines were designed and constructed under the patents of Messrs. H. Lange and H. Livesey, by the firm of Beyer, Peacock & Co., in 1887, and a general elevation of them is given above. It will be seen that the general design of the locomotive is that of a side-tank engine, having two pairs of carrier wheels, which in an ordinary engine would be the driving and leading wheels, together with a trailing two-wheeled bogie. The boiler is of the usual locomotive type, but as will be seen from the figures given below, is of large dimensions in proportion to the cylinders; the shell of the firebox and barrel is of steel, the firebox of copper, and the tubes brass; it is fed by two injectors, and is worked at a pressure of 150 pounds per square inch. In order to accommodate the water level as far as possible to both the level line and to the extreme grade on which the engines work, the boiler is not fixed horizontally on the frames, but at an angle of 1 in 24. The engine is designed to work on a central rack rail, and has no power of propulsion when on an ordinary track, the wheels being carriers only. The motive power of the engine is transmitted through two cog wheels placed between the two carrier axles and mounted on two axles which revolve in bearings carried by frames on each side of the engine, fixed to the axle boxes of the carrier axles. It will thus be seen that rather more than two-thirds of the total weight of the engine, resting through the bearing springs on the axle boxes of the carrier wheels, is utilized to prevent any up-thrust from the working of the cog wheels in the rack. At the extremity of each cog axle is attached a fly crank connected with the steam cylinder in the ordinary manner. The cog wheel axles are each worked by a separate pair of cylinders, and are not connected together by coupling rods in the usual way. By this arrangement each cog wheel must of necessity perform its proper share of the work, no matter how great the inequality of the rack; and although four cylinders are required, they are worked by two sets of valve gear of the Walschaert type actuated by a return crank on the hind motive axle. The engine is fitted with three independent brakes, namely, two powerful hand-screw brakes, one acting on the four carrier wheels, and the other upon grooved drums fitted to each side of the cog wheels; the third is an improved counter pressure air brake acting upon the pistons. This brake is used in descending the incline, and not only saves the wear and tear upon the tires and rails, but also that on the cylinders caused by the products from the smoke box, which would be drawn into the cylinders when the steam is entirely shut off. The principal dimensions of the engine are as follows:

| | |
|---|---|
| Cylinders (four) | 11¼ in. in diameter by 18 in. stroke |
| Cog wheels (two) | 2 ft. $1\frac{9}{16}$ in diam. on pitch circle |
| Carrying wheels (six) | Four front wheels, 3 ft. 6 in. in diameter, on fixed axles; two hind wheels, 2 ft. 6 in. in diameter, on a bogie axle |
| Length of rigid wheel base | 8 ft. 9 in. |
| Total wheel base | 16 ft. 10 in. |
| Tractive power per pound pressure on piston area | 178·6 pounds |
| Working boiler pressure | 150 pounds |
| Heating surface | 1,167·5 sq. ft. |
| Grate area | 17·5 sq. ft. |
| Capacity of tanks | 540 gallons |
| Capacity of bunker | 19 cubic feet |
| Weight of engine in working order | 40 tons |

The incline on which these engines work commences at Trincheras station, 1,188 feet above sea level, and rises with grades of 1 in 21 and 1 in 28 for 4,000 feet, and then a continual grade of 1 in 12½ for a distance of 7,700 feet, when the summit is reached, the length of the incline being 2¼ miles. The curves are of 500 feet radius, the gauge of the railway being 3 feet 6 inches. The rails are of flange section, weighing 55 pounds per yard, and are fixed to steel transverse sleepers, in the center of each of which is bolted a cast iron chair, carrying the rack, which is of the "Abt" type. The incline is situated midway between the seaport of Puerto Cabello and the terminus at Valencia, and the trains are brought by ordinary adhesion engines to and from the incline on either side, the rack engines then taking their place. The trains consist usually of four bogie wagons, each loaded with 10 to 11 tons of merchandise, or a total gross weight, exclusive of the locomotive, of 70 tons, the rack engine being always placed at the lower end of the train.—*Engineering.*




RACK RAIL LOCOMOTIVE, PUERTO CABELLO AND VALENCIA RAILWAY.

## THE BROADWAY CABLE, NEW YORK.

IF one stands astride the narrow slot which is, as it were, an artery through an artery of our great city, on Broadway, and watches the snaky cable as it glides along, he must pause a moment to consider before he can realize what an enormous amount of power it carries and what experiences it has to go through. Cruelly gripped by the mechanism beneath the cable cars and straining as it passes over curves, it has indeed a hard road to travel. What stories it could tell!

Before we tell the history of the cable, let us see of what it is composed. A strong hempen strand five-eighths of an inch in diameter forms the inner core; around this are wrapped six steel cables, which are in turn composed of seven strands wrapped around with other strands of steel wire, the whole making a total diameter of one and one-half inches.

A steel rod three-eighths of an inch in diameter and one foot in length weighs approximately one pound. The difference in weight between this cable and a steel rod of the same size may be realized when it is known that this cable weighs but three pounds to the running foot. The use of the central hemp rope is for the purpose of giving a certain pliability.

In order that rust and decay should be avoided, the rope is kept smeared with tar and oil. This is what causes the black, shiny appearance. As one of the cables which obtains its power from the Broadway cable house is 20,000 feet in length, it is not difficult to determine the entire weight, which in this case would be 60,000 pounds. The market price of cables being about 40 cents per foot, the cost of this would be in the neighborhood of $8.000 for one coil of wire. The Broadway company maintains six cables, and as the

approximate life of a cable in our busy thoroughfare is little more than eight months, it would appear that the expense caused by the renewal of cables is not a small item. In Denver, Col., longer cables than these exist, the one on the main street being 36,900 feet in length, having a diameter of but one inch and a quarter. Owing to the fact that there is less traffic in the latter city, the work required from the cable is not so great. Its life is slightly lengthened, and ten months may be put to its credit.

It is quite interesting to watch the peculiarities of the cable, and when we stop a moment to think how the gripmen when they reach the termini of a line have the destruction of $8,000 worth of property in their power, we can see that some means is yet to be devised which will perform automatically the action of throwing off the grip, for unless the grip is loosened as the car approaches the power house, when it reaches the place where the cable descends to the driving wheels something must give way, and while the cable generally has the best of the encounter, very often a couple of strands are ripped, which entails considerable work upon the repairers.

At the Broadway power house, Mr. M. Moore is the person who is technically known as the "splicer." He was brought from Denver, where he had been in charge of the cable in that city. He has about eight or ten men under him, who, with dexterity, make necessary repairs.

Cables are in a measure human. They have their diseases and they need their doctors. Mr. Moore is the medical examiner, and from him we received several points concerning the troubles to which the cable is subjected.

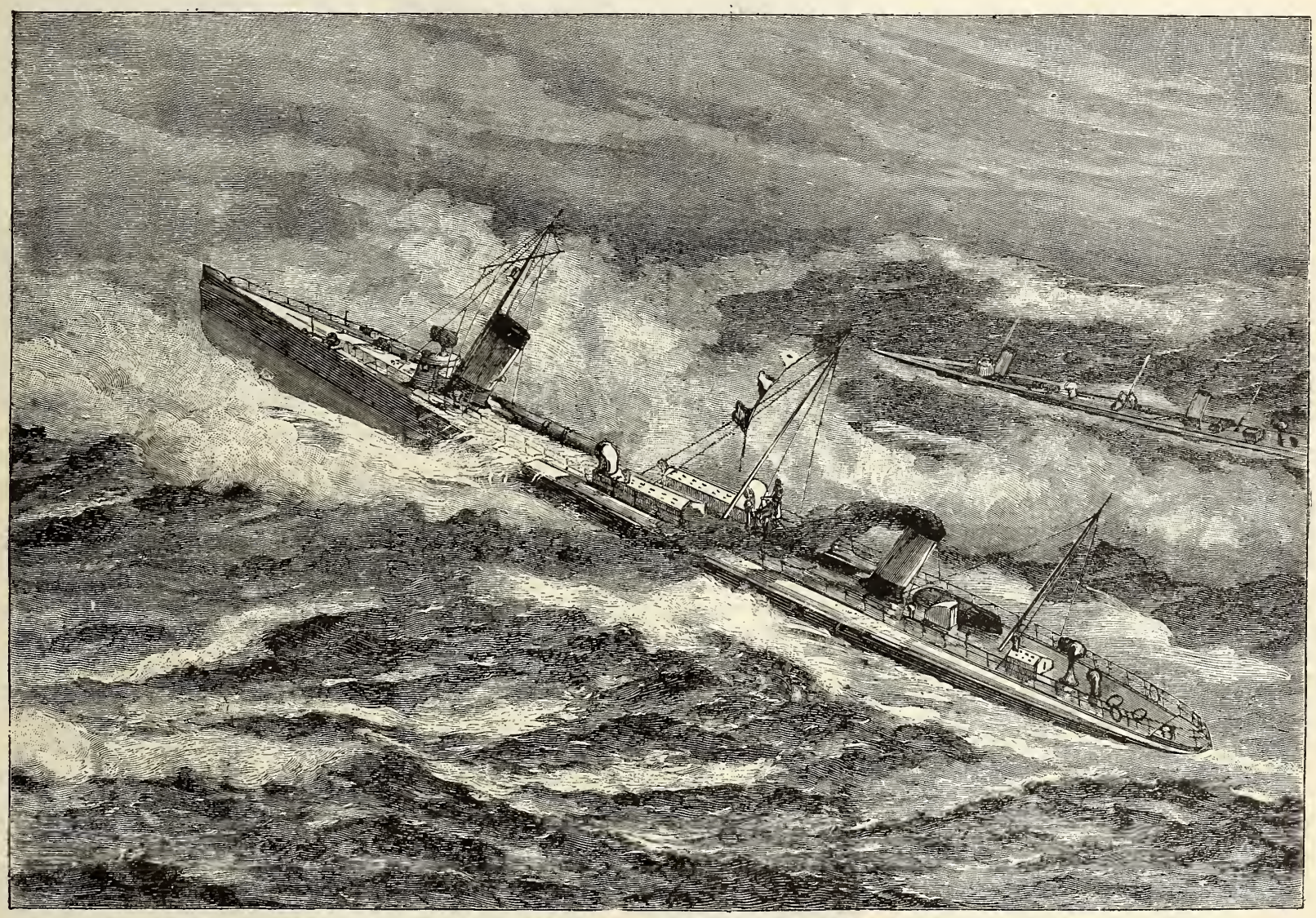
In case a cable has become bent in any way, it is difficult, in fact almost impossible, to straighten it absolutely. The bend remains, and if we stoop down to watch its onward approach it looks like a huge sea serpent, wriggling toward you, performing wonderful gyrations as it approaches. Several of these "kinks," as they are termed, have been made in the up-town cable, which travels at the rate of 810 feet per minute. As the rate of the cable is invariable, by simply looking at the clock, the man whose sole duty it is to watch the cable can tell at exactly what place the "kink" is situated. As a matter of curiosity we inquired of the watcher at the Sixtieth Street power house when the next "kink" would arrive. Looking at his watch and hastily making a mental calculation, he answered, "Between 4:11 and 4:12." In fact, the "kink" came in sight immediately as the hands of the watch pointed to eleven minutes after four.

With the Bowling Green cable, however, few "kinks" occur. The line is straighter and does not run under dangerous curves like those at Fourteenth and Twenty-third Streets. It might be well to mention here that, unless the grip is held fast to the cable as the curve is rounded, the enormous friction, resulting from the slipping of the cable through the grip at this point, would be sufficient to "burn" the strands or grind the grip; in either case doing considerable damage.

While it is easy to localize accidents, it is difficult to assign causes. However, recently, for some reason or other, the Bowling Green cable had about 1,000 feet of strands ripped off, and the writhing, curling mass of wire, as it lay upon the floor of the power house, presented a most confused appearance, and one would be led to wonder how puny man could have the power to cope with such an apparently unwieldy mass. With huge shears, however, those pieces of metal are snipped off, and a new cable must be put in place of the damaged portion. The splicing is an interesting operation. Unlike rope, the strands are extremely difficult to manipulate; yet, with skill acquired from the continual work, each strand is woven into place among other strands, heavy pliers and marlinspikes being used to separate the layers. When all is done, about four inches of the ends of each strand are left outside the cable, and by continued wear they finally break off and the splice becomes practically as a virgin cable. Even the trained eye of Mr. Moore is unable to detect the splice after the wires have been thoroughly covered with tar. The joint is as firm and as strong as the original cable.

Delicate hands are out of place in this work, and cable splicers are veritably "horny-handed sons of toil." Their work is done mainly in the wee hours of the night, when traffic is at its minimum. Mr. Moore assures me that with his eight or ten helpers he can splice in a thousand feet of cable in one hour and a half.

At the Broadway station, far down underground, in regions damp and dripping with steam and tar, one may see the tension carriages, which play backward and forward on their slimy beds, with the restraining forces of the cable in one direction and the tension weight of 4,400 pounds in the other. Everything is oil and tar, but the atmosphere is kept reasonably pure by a huge ventilating fan. Around and around the ponderous wheels revolve; onward glides the snaky cable, and, with eyes ever alert for approaching danger, the tireless watcher sits and waits for kinks or broken strands.—*Electrical Review.*



## THE NEW BRAZILIAN TORPEDO BOATS.

### THE NEWEST SCHICHAU TORPEDO BOATS—BUILT FOR THE BRAZILIAN GOVERNMENT.

THE firm of Schichau, of Elbing, has gained a world-wide reputation on account of the great speed of its torpedo boats, but lately it has given new evidence of its ability as a shipbuilding firm by adopting a new method of construction, by means of which boats have been produced that are even faster than those formerly made by this house. We refer to the five torpedo boats recently purchased by the legitimate Brazilian government, which, when fully equipped, developed a speed of 28 knots an hour on the trial trip, showing them to be the fastest vessels in the world. They are each 152 ft. 6 in. long between the perpendiculars, and the double screw is driven by two three-cylinder engines, that develop 2,200 horse power, the steam for which is generated in two locomotive boilers. These little boats had to cross the ocean in severe winter weather, so as to reach their destination, Pernambuco, Brazil, as soon as possible. One would suppose that, under such circumstances, it would be difficult to get officers and men, but the confidence in the vessels and the engines was so great that enough men were found to bravely undertake the hazardous task and carry it out successfully.

It would have been interesting to accompany these bold seafarers on their voyage. Each of the five boats was provided with a tried captain, a pilot, and fifteen men. The last of November they left Pillau for Kiel, where they were thoroughly equipped for war, and then they passed through the Eider Canal to the North Sea. Both there and in the Channel they experienced very stormy weather, and were detained at Dartmouth two weeks by a hurricane. Boats One, Two, and Three started from here December 26, steering in a direct line for Las Palmas. In the Bay of Biscay they had to pass through a severe test, for a westerly storm drove the waves as high as a house, boiling foam and crushing breakers dashed over them, but they proved to be entirely seaworthy, passing through the flood as smoothly as an eel, and plunging with a graceful motion from the crest to the trough of a wave. There was no warm food for the crew while the storm lasted; cooking could not be thought of when there was such terrible motion, and for days a piece of bread and a swallow of brandy was the only nourishment taken. The boats reached Las Palmas in good condition, and they were kept in quarantine four days. Then they went to St. Vincent, where they had to remain in quarantine five days more. From there they steamed across the Atlantic to Pernambuco, where they arrived January 19, in good condition.

Boats Four and Five left Dartmouth on December 31, and followed in the course taken by the others. They were quarantined in Las Palmas for one day, and at St. Vincent for eight days. On January 26 they also reached Pernambuco in good condition. During the entire voyage only one boiler was used at a time, the boats making a speed of 16 knots. After a brilliant trial, the five boats were accepted by the Brazilian government.

The great confidence felt in Germany in the Schichau boats is shown by the fact that the insurance companies insure them at 1⅓ to 1½ per cent., while the English companies demand 4 to 5 per cent. on English vessels.—*Illustrirte Zeitung.*

### LIQUID FUEL AT SEA.

IT has often been asked why it is that steamers carrying some thousands of tons of petroleum in bulk should fill their bunkers with coal. Although it is true that petroleum in any but the crudest form is an exceedingly expensive fuel if purchased in England, it is not necessarily costly if bought on the Black Sea or in the United States. Indeed, unless a steamer carries coal enough for the voyage out and home, petroleum would not compare very badly with it if bought in a Black Sea port. In South Russia coal for railway purposes costs from £2 10s. to £3 per ton, and petroleum has been substituted for coal by Mr. Urquhart with very great economy. On the Black Sea and the Caspian ply dozens of steamers using liquid fuel. There is no lack of precedent, yet in the mercantile marine liquid fuel has up to the present found no place. Considerable interest under the circumstances attaches to an experiment now being made by Mr. A. Suart of London. He has fitted a large tank steamer, the Baku Standard, with appliances for burning astaki, and she recently completed a voyage to Philadelphia from Shields, burning only liquid fuel. She then made a return trip to this country, and has since sailed again. So far as we are aware, this is the first instance on

record of a steamship fitted to burn liquid fuel and making an ocean voyage. Hitherto there has always been a breakdown of some kind during the trial. The Baku Standard registers 3,705 gross tons, she is 330 ft. by 43 ft. by 23 ft. deep. She carries 1,200,000 gallons of petroleum in bulk, and goes to Russia as well as the United States for oil.

When we come to consider particulars, it will be seen that the Baku Standard made her voyage under difficulties; instead of the usual crew of firemen and trimmers, only three boiler tenders were shipped. One met with an accident soon after the ship sailed, breaking a collar bone, and was laid up. The result was that the other two men had to stand six hours watch and six hours watch on the rest of the voyage, which they could scarcely have managed if they had had to work hard shoveling coal and cleaning fires. As a fact, however, the fires seem to have needed little or no attention, even in the worst weather, and so far the venture has been quite successful. The consumption of oil was about 20 tons in the twenty-four hours. Taking the oil as being twice as good as coal, this means 40 tons of coal a day, and with good triple expansion engines, this should give 2,500 indicated horse power. The engines of the Baku Standard, however, do not iudicate anything like this, and we shall perhaps overestimate the efficiency of the astaki fuel if we say that 20 tons of it were equal to 30 tons of coal, which would give 1,500 to 1,800 horse power. No doubt the cost of astaki was greater than that of coal, but against this must be set the greatly reduced cost of the fire room crews—so many fewer mouths to be fed, and so much less wages to be paid. So far Mr. Suart seems to be contented with the result in all respects but one, and that is the old trouble that has arisen over and over again when petroleum fuel is used in conjunction with surface condensing engines. A very serious quantity of steam is used in "spraying" the astaki. This represents so much waste, but that is by no means the worst of the matter. The steam thus drawn off from the boiler goes into the chimney in one form or another, and the auxiliary feed has to be employed to make up the loss. Salt water cannot be pumped into the boilers, fresh water enough cannot be carried, and consequently an expensive and heavy evaporating plant must be fitted and worked with liquid fuel. It is very easy to underestimate this item; when we say, however, that during the first voyage of the Baku Standard the weight of steam required to spray the oil exceeded that of the oil, reaching to over a ton an hour, some idea may be formed of what it represents in the way of loss. Allowing 20 lb. of steam to give a horse power—a very ample allowance for a good triple expansion engine—we see that a ton of steam per hour means about 112 indicated horse power; and allowing that 1 lb. of astaki will evaporate 15 lb. of water, it means that not less than 3,600 lb., or over a ton and a half of astaki, had to be burned every twenty-four hours for the purpose of supplying fresh water to the boilers. This represents a very considerable addition to the cost, and it certainly seems strange that considerably over 100 horse power should be required to force the fuel into the furnaces. We understand that a different set of burners is now being tried, and it is hoped that the auxiliary feed required will be reduced from 25 tons to 10 tons per twenty-four hours.

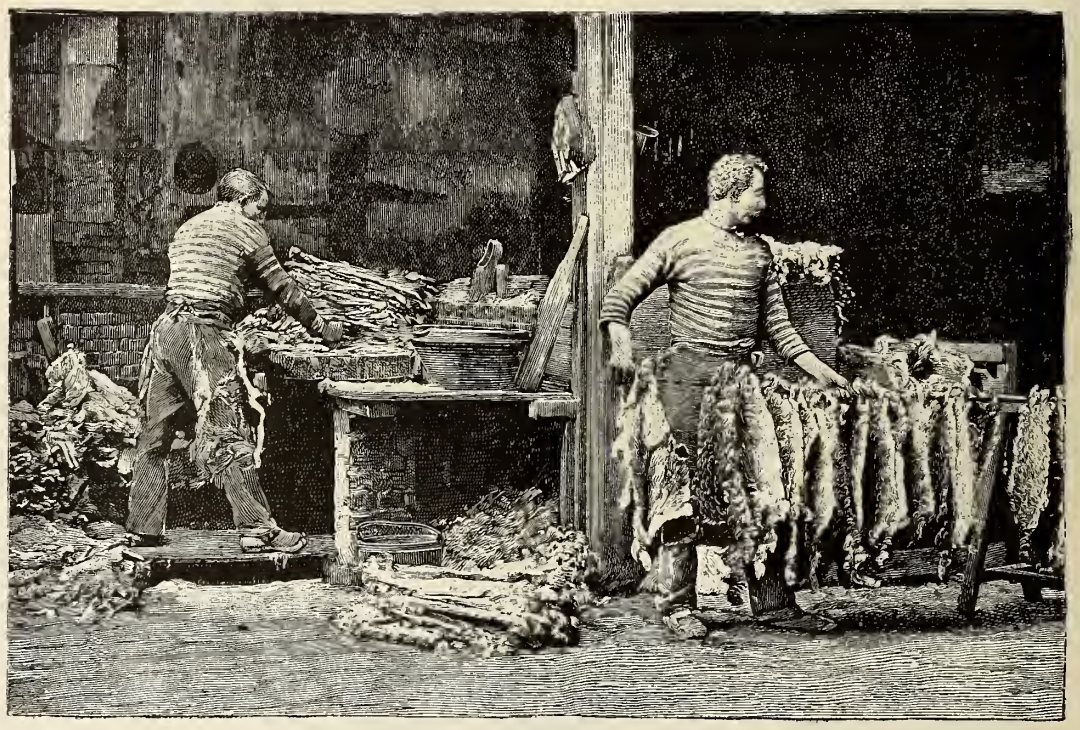
There remains for consideration the difficulty involved in handling the petroleum. In the Baku Standard as at first fitted the stuff was pumped up from special bunkers into two small tanks in the funnel casing, where it becomes more fluid than water, and from these tanks it ran down to the furnaces through suitable pipes. It appears that this arrangement has had to be modified. There is great difficulty in dealing with the oil in the bunkers when they get partially empty. It is well understood that oil tanks should always be kept quite full. There is absolutely no danger of an explosion when air is kept out; the difficulty is to prevent the accumulation of an explosive mixture of air and petroleum vapor in the bunkers when the level of the air falls in them. It is very easy to say that means of ventilation can be provided; not so easy to do it. The bunkers in the Baku Standard are insulated from the boilers by cofferdams filled with water; but the two service tanks cannot be so insulated, and if they leaked, or any of the pipes or fittings, there would be a serious risk of fire incurred. We believe that two other vessels belonging to Mr. Suart are to be altered to burn liquid fuel; so that the experiment, it will be seen, is being carried out on a scale commensurate with its importance. "Lloyds," it is worth while to add, are throwing no obstacles in the way; on the contrary, they, as usual, treat the whole subject broadly. The surveyors satisfy themselves that the arrangements for carrying the oil are satisfactory, and then they enter in the register book, "burning liquid fuel, experimental."

What the outcome of the experiment may be it is impossible to forecast with any pretense to accuracy. It may be that petroleum steamers as a class will find it to their advantage to burn petroleum instead of coal. It would seem, however, that the economy must be indirect rather than direct; the fuel as fuel will be more expensive than coal, but the handling of it will be much less costly. There may also be a saving in the upkeep of furnaces and boilers. It seems that the introduction of some other method of burning the oil, instead of a steam jet, would be advantageous. The loss of feed water would thus be avoided. It might be practicable to employ compressed air instead of steam, and it is scarcely probable that 110 horse power would be expended in compressing air in such a ship as the Baku Standard. It remains, indeed, to be seen whether mechanical means may not be found for accomplishing the same end. It is a curious fact that notwithstanding its high inflammability, it is very difficult to burn petroleum at once thoroughly and rapidly. Thus we find that unburned oil will drop even in the furnace of a locomotive on the coke or lime on the grate, and the unburned oil may be seen sputtering on the white-hot fire brick opposite the nozzle, and then igniting, the fine drops having had to pass through a zone of intensely heated flame before they could reach the fire tile. Up to the present it is true that nothing has been found to answer so well as the steam jet, but it does not at all follow that finality in this direction has been reached, and there is so little to be said in favor of the steam sprayer in use at sea that we may expect inventors to work hard to devise something better. Yet when all that is possible has been done the use of petroleum must remain limited, the whole weight of it available for fuel being as nothing compared to that of the coal burned each year.—*The Engineer, London.*

## RABBIT SKINS.

Æsop, Phædrus, La Fontaine and Florian loved the rabbit for its gentleness, its innocence and its submissive philosophy. We, more practical and unfortunately less imaginative, esteem it especially for its flesh and its pelt.

The trade in rabbit skins prepared for furriery and felting is not, as generally thought, a business of small importance, a negligible quantity in our immense traffic, but, on the contrary, is one of the interesting branches of Parisian industry, giving employment to at least four thousand furriers, dressers, dyers, cutters and mounters, without counting the itinerant purchasers whose cries we continually hear in our streets.



"SECRETING," OR ACID DRESSING—THE STOVE.

The annual manufacture in the principal works in which these skins are treated exceeds two million pieces, causes the circulation of $800,000 in cash and gives livelihood to about five hundred workmen at a mean salary of ninety cents a day. Do not these figures clearly show the activity of this trade in a city in which, despite the great prosperity of the business, it is almost unknown to the public?

The leading quality of the rabbit does not reside in its flesh. This gentle quadruped, which

"*de thym parfume son banquet,*"

furnishes more than a vulgar stew. Like Horace, it does not perish entirely, and its departure from this life only serves to increase its utility.

Entirely revised and corrected by mechanics and chemistry, its fur, upon its exit from the works, possesses a luster and aspect that forthwith ennoble it. The modest inhabitant of the burrow then becomes an otter, ermine, beaver or fur seal! How many boyars and lords of the Boulevard Montmartre there are who think they are wearing a heraldic pelisse, when they are merely taking a dozen beautiful rabbit skins out for a walk!

Every one knows how the merchandise is obtained. Rich retail dealers, in a blue blouse like laborers, but whose daughters are well dowered, buy it from the itinerants. Three cents apiece is paid for it, provided it exhibits no holes, nor rents, nor scurf. Fifty skins are made into a bundle and delivered to the furrier without any other preparation than a summary beating. This centralization and transit leaves in the hands of the dealers a profit of about two cents per skin, since the selling price is from five to six cents.

The largest dealers are located in the north, in the vicinity of Paris, at Amiens, Beauvais and Reims. No trade in fine skins designed to "pass into fur" is done beyond a line that may be traced from Lyons to Rochelle. In the south, the rabbit is small, poor and short. Its hair is good for nothing except for felting.

The most esteemed skin is that of the silvery rabbit of Champagne. It may be employed directly without dyeing, as if it were derived from that graceful animal of Archangel called the Siberian squirrel. Unless one belongs to the trade, it is impossible to recognize the substitution only because it is . . . impossible! It is a singular and capricious fashion that desires defects in furs, blemishes in the diamond and typographical errors in "good editions."

The skin of the silvery rabbit is quite expensive, because it is rare as well as difficult to match. The first quality of a manufactured fur is, in fact, that of being equal in shade and marking.

As soon as the bundles reach the furrier's works they are opened and the skins counted and carefully sorted. It is important to recognize the merchandise and to classify it. The fine pieces are reserved for furs, while the others pass to the hands of the cutters of hair.

This cutting of the rabbit hair is not so simple as it appears. It requires ten operations in succession. From the time of Pliny the elder, and doubtless before the time of that observer, it has been remarked that the hairs of certain animals, such as the rabbit, beaver, camel, sheep, etc., intercross and shrivel when they

THE REPAIRERS.

are fulled mechanically. It is in this way that it has been possible to manufacture solid and durable fabrics without the necessity of weaving them. Such are the felts and the buckrams. The hair of the rabbit is undeniably the kind best adapted for this industry.

In the first place, the dry and hardened skins are soaked in water. After allowing them time to become flexible, they are placed, hair downward, upon large wooden cones in order to stretch them. These cones open in two parts, like a glove stretcher, thanks to an interior screw actuated by a small hand wheel. After the skin has yielded as much as possible without cracking, it is split by passing a sharp knife through from bottom to top on the belly side. The piece is thus opened and stretched and ready to be plucked. What are called "pluckings" are the coarse and long hairs that extend beyond the rest of the fur. The women engaged in this work earn good wages. They generally work by the piece, and often for fifteen hours at a time in an atmosphere filled with dangerous dust and hairs. So they rapidly lose their appetite and gradually travel toward the hospital. When questioned, they cheerfully answer: "Our trade nourishes!" Alas! What a nourishment is this slow continuous obstruction of the digestive and respiratory tracts! This is the reverse of progress. The pluckers make use of a sharp blade and of a leather or rubber

CUTTING MACHINE.

thumb stall to avoid cuts. They all cover their head with a *marmotte*, and take precautions for their hair that they ought really to take for their lungs and stomach. The waste (the cuttings) is sold for the benefit of the operatives. It brings a small amount of money, which is distributed throughout the entire shop.

After the skins have been divested of all the plucking, they are subjected to a dressing called "secreting;" with a bristle brush dipped in a tub containing a certain wonderful solution, the hair is thoroughly wet in such a way that it shall be rendered humid as far as to two-thirds of its length. This solution, which is now known, was of old one of the arcana of industrial alchemy. When the formula for this mixture was asked of the old furriers, they assumed the airs of Dr. Faust, and silently put their forefinger to their lips. This was all their answer. Now, the following is the secret of the "secreting" (acid dressing):

| | |
|---|---|
| Pure, slightly tepid water ..... | 3 qts. |
| Nitric acid (by weight) ..... | 15 oz. |
| Mercury " " ..... | 2 " |

This mixture has the property of preparing the hair for felting. Certain furriers claim still in our day to have a "recipe," but we can assure them that their enchanted philters would not stand for an hour before the box of reagents of the director of the Municipal Laboratory.

The skins, having been well acid-dressed, are strung by dozens upon iron rods and carried to a stove, wherein they are dried. After a few hours, the rods are taken out, the skins are aired, and the legs, tails, and useless parts—those that exceed a pattern adopted as a type—are cut off. Then the hair receives a dry brushing in order to render it loose, and the skins are carried to the shop wherein the steam cutting is to be effected. The wonderful machine that performs this fairy trick is certainly the sister of the one that in 1855 was jokingly recommended to the troops of countrymen who came to take a look at the Universal Exposition.

"This machine," it was then said, "makes a stew and a hat out of a rabbit in three minutes!" Well, the machine under consideration, in the twinkling of an eye, forms from a rabbit skin a little pile of silky down and a package of "vermicelli"! This miracle is performed upon a table upon which are installed a stationary knife and a rotary one. It suffices to introduce the extreme end of the skin in order that all

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shall pass therein and be intelligently divided as we have stated.

The hair thus cut is deftly made into bundles by light-fingered women, who trim it, pluck it, and mount it in hemispherical bags. It is sold in this shape to the felters, who pay at the rate of about a dollar a pound for it.

The belly hairs, which are set apart, are not so dear, and cost about 60 cents. The pluckings are not thrown away, but are sold for carpets and for buckrams, which are imperfect felts, or are utilized for the manufacture of crews' mattresses for vessels making long voyages or for emigrant ships. As for the "vermicelli," glue is made of that. Nothing is lost in the industry, but all is transformed, because thus everything can be sold.

Now let us pass to the fur work, which has nothing in common with the preceding. Here the domestic rabbit is absolutely preferred to that of the warren, and to the hare even. Its size and the beauty of its hair are the causes of this merited favor. Moreover, as the rabbit of the warren is too often massacred by hunters, three-fourths of the skins derived from this animal are not utilizable for furs. They are "skimmers."

After the sorting and cutting off of the tails, legs, etc., the open skin is sewed up with a few rapid stitches. A sort of a purse is made of it, hair against hair, which is covered externally with the residue of colza oil. After the skins are well saturated, and the derma has become sufficiently soft, they are submitted to the action of the fulling mill, an apparatus composed of a large trough and two huge rounded hammers, which pound and repound the mass without bruising it. After a few instants of this energetic fulling, the rabbit skins become less recalcitrant, and acquire a flexibility comparable to that of the best glove. They are then given over to the "scrapers."

These workmen form the cavalry of this army of artisans. They are continually in the saddle upon a horse whose principal piece is a terrible saber in the form of a crescent. Holding the skin with both hands, they draw it, scrape it and render it thin by passing it quickly over the knife. Woe to the awkward man who makes a miss. The huge knife does not forget him who forgets it. It is true that the workmen know at once how to find a remedy for the trouble. A small piece of skin applied to the wound is the best of all diachylons.

The skins, having thus been freed from all rough or indurated parts, are mechanically scoured in large drums which, in revolving, make the sinister noise of the instrument of Ixion. These contain plaster, sawdust and three or four hundred skins. This operation is renewed twice and lasts four hours. After leaving the drum, the skins pass to the steam beater, in which they are lashed in a magistral manner amid a fearful cloud of dust. Upon making their exit, they are again smartly drubbed by a dozen young apprentices armed with rattans. Finally, they are sheared more or less closely, according to the imitation that it is desired to make of them. Sheared very short, it is the seal; less so, it is the otter; still less, it is the beaver.

Afterward come the repairers, whose art consists in repairing all the imperfections that the skin may present. It is, in fact, quite a rare thing for a piece to be without any defect. With a skill, sureness of eye and incomparable hand, the repairer removes the defective piece, selects from a pile of cuttings a similar part having the same shade and the same luster, and, in four cuts of his knife, completes the fur that he is treating. There are some skins that are mended in from five to eight places. If you have the eyes of a lynx look for them, and again put on your spectacles. It is impossible to find the juxtapositions of this mosaic work.

A careful combing terminates the work of the repairers and sets free all the hairs that have become matted. Here again comes a new classification, embracing on the one hand the skins that are to remain

in their natural color and on the other those that are to be dyed.

Before being dyed each skin is saturated several times with a special mordant whose composition is still an alleged secret. After each application of mordant the skin is dried in a stove. Finally, the skins are thrown into huge vats filled with black mixed with other ingredients, among which the copperases play the principal role. After they have remained for a whole day in this thick mixture, the skins are submitted to the action of a press quite similar to a wine one. They are then examined, and, if they are not sufficiently colored, are put back into the vats until the black saturates them. This result having been obtained, they are scoured for the last time and dried in the free air in vast latticed structures. The last classification is then made and they are arranged in dozens. The mean value of such packages is from five to six dollars. As may be seen, the Paris "otter" is much cheaper than that of Kamtschatka. In reality it is not so beautiful, but the immense difference in price is not justified by the difference in quality, and so much the more so in that the majority of the true otter, seal and sable skins, even, have likewise to undergo mordanting, secreting and dyeing in order to become salable and be delivered to consumption.

The production of the Parisian works that treat the skin of the rabbit is about twelve million pieces. Belgians also are engaged in this industry, but they proceed by tanning.

The French fur dressers have a universal and merited reputation. If London is the first market for peltry in the rough, Paris is the most important of points of re-exportation for dyed furs. The quantities employed in France reach scarcely an eighth of the total manufacture, and the port of Havre annually exports more than six million dollars' worth of peltry, hair and felt. The United States in the first place, and then Germany, Sweden, Norway and Holland, supply themselves in Paris when their furriers desire first-class goods. Our prepared and dyed peltry, particularly that of the rabbit, is esteemed not only in Europe and America, but also in Asia, and especially by the inhabitants of the Celestial Empire.

In 1860, after the taking and sacking of the State

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Palace, a quantity of rare objects derived from the historic pillage arrived at Paris. There was a little of everything in this immense military housemoving—vases, bronzes, furniture, arms, mandarins' clothing, and, of course, mandarins' furs. The happy possessors of those extra-oriental pelisses believed that they had laid hands upon sables beyond competition. They were appraised here, and what was not the disappointment of the assistants to learn that these undiscoverable mantles were derived from animals which had been raised from tender infancy in Paris, and *Sentaient encor le choux dont ils furent nourris.*

However this may be, our soldiers had entered Pekin, where our French furs had already preceded them.—*Le Monde Illustré.*

## THE MANUFACTURE OF STRAW CELLULOSE.*

By James Beveridge.

The manufacture of cellulose or paper pulp from the various kinds of straw is so well known to experienced paper makers that it is probably difficult to mention anything specially new in dealing with such a subject. This statement may also be made in regard to other fibrous plants besides straw, and it may be deemed unnecessary by some that one should occupy the time of our society on such a trite subject The manufacture as a whole is, however, unquestionably a difficult one, and there are certain problems associated with it which are of great importance to pulp and paper makers, and certainly of more than passing interest to the technical chemist.

Straw has been used for paper making from very early times. It is said that the Chinese manufactured paper from rice straw before the Christian era. This art, originating with them, gradually extended to Europe through Spain, Germany, France, Holland, and finally to England. The rapid development of the industrial resources of Europe at the beginning of this century, and our ever increasing social requirements demanding the extension of our paper industry, told heavily on the supply of rags, and gave a great impetus to the manufacture of paper pulp from fibrous plants. The scarcity of rags to meet these requirements not unnaturally caused paper makers to turn their attention to straw, because of its universal distribution and abundant supply. The invention, too, of a method of manufacturing a comparatively cheap and inexhaustible supply of alkaline soda products from common salt by Leblanc practically placed the chemical treatment of straw—as indeed all other fibrous plants—on a sound manufacturing basis. Since that period and the rise of the alkali industry in England, the inventions of Weldon and Deacon relating to the manufacture of cheap chlorine have added much to the development of the straw pulp industry. Indeed, it may be said with perfect truth that the success of this manufacture to-day fluctuates with the market value of soda and bleaching powder.

There are two kinds of pulp made from straw, viz., straw pulp proper and what may be more correctly termed straw cellulose. The former is made by steeping the straw or boiling it under pressure with milk of lime until it is thoroughly softened, after which it is washed and ground with suitable machinery and manufactured into a cheap quality of wrapping paper. This method is employed extensively in France and other countries of the Continent where there is a demand for such papers, but, so far as I am aware, is not used in England to any great extent, excepting probably in the manufacture of straw boards.

Although the subject of this paper has nothing to do with this kind of straw pulp, yet it may be mentioned incidentally that the chemical action of the milk of lime on the incrusting materials surrounding the straw fiber is not a vigorous one. These incrusting materials are not completely, nor indeed to a great extent, separated from the cellulose. The mineral matter remains in the product practically untouched, and if any less quantity than that corresponding to the percentage in the original straw operated upon exists in the prepared pulp, it is due rather to the washing after digesting than to any solvent action of the milk of lime. The milk of lime, under certain conditions, has a bleaching action on the straw. It neutralizes the organic acids usually formed when fibrous plants are heated for any length of time in presence of water. The yield of pulp obtained by such a treatment amounts to from 75 to 85 per cent. The papers produced from this pulp are of a very poor quality, and wholly used for packing purposes. They are hard, brittle, and possess a low tensile strength.

The preparation of pure cellulose from straw is a very different manufacture, and involves a cycle of operations, each one of which requires the most careful supervision. The product is used for the production of papers of first-class quality, fine and medium writings, for example, and must be well prepared, and as free from dirt as it is possible to get it. It is therefore necessary that cleanliness be observed in every department, and that the straw itself and the water used for washing, etc., be subjected to a preliminary purification, as necessity may require, before they enter the mill. It will only be necessary for me to touch lightly upon a series of operations through which the straw passes, and in order to make the whole subject plain, I will subdivide it into the following divisions:

I.—Straws. Their composition, nature, etc.
II.—Manufacturing operations.
(*a.*) Cleaning, cutting, and dusting.
(*b.*) Digesting the straw in caustic soda lye.
(*c.*) Washing, breaking, purifying, and bleaching.
III.—General data *re* (*a*) yield, (*b*) bleach, (*c*) loss of soda, etc.
IV.—Fuel and mechanical power required to produce a ton of straw cellulose.

### I.—*Straws: Their Nature and Composition.*

The straws usually employed for the preparation of cellulose are those obtained from the cereals, oat, wheat, rye and barley. In some parts of the Continent maize straw has also been used, but I understand with only moderate success, as it yields a somewhat coarse fiber. Next to wood, oat, wheat, rye, and barley straws are the most universally distributed fibrous plants, known as sources of paper pulp. In point of cheapness they also rank next to wood, which is recognized as the cheapest source of cellulose at present known in this country. The physical character and composition, especially with regard to their ash contents, vary enormously. This is not only true of the different kinds of straw, but also of the same variety, and seems to depend upon the district or country in which they are grown. Probably the soil has influences on the composition of the ash as well.

The fibers contained in these straws are loosely bound together by resinous and intercellular matter, which is easily dissolved by caustic soda, and subsequently separated by washing. Thus isolated they are soft, flocculent, and admirably adapted for use in the manufacture of high class writing papers. They differ slightly from one another in their paper-making qualities; the fibers from barley straw, for example, differing from those of oat, wheat, and rye in length, breadth, and general physical character. This difference is very noticeable when the pulp from each of these straws is separately brought forward in the mill.

Composition of Straws.

(By the method of digesting in bi-sulphite of soda.)

| | French Wheat. | Zealand Wheat. | Dutch Wheat. Ijpolden. | Dutch Oat. | Dutch Rye. | Dutch Barley. |
|---|---|---|---|---|---|---|
| Water | Per Cent. 11·8 | Per Cent. 8·2 | Per Cent. 12·5 | Per Cent. 11·2 | Per Cent. 7·6 | Per Cent. 11·0 |
| Ash | 7·2 | 10·0 | 7·5 | 5·5 | 1·8 | 7·2 |
| Cellulose (unbleached) | 36·6 | 37·6 | 36·4 | 37·3 | 41·3 | 34·1 |
| Organic matter other than cellulose | 44·4 | 44·2 | 43·6 | 46·0 | 49·3 | 47·7 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| Per cent. dry cellulose on dry straw | 41·5 | 40·9 | 41·6 | 42·0 | 44·7 | 38·3 |
| *Per cent of air dry cellulose on air dry straw | 40·6 | 41·8 | 40·4 | 41·7 | 45·9 | 37·9 |
| Per cent. silica ($SiO_2$) in straw | 4·40 | 6·24 | 5·17 | 2·35 | 0·92 | 2·06 |
| Cwts. straw to produce 1 ton of air dry cellulose | 4·9 | 4·78 | 4·95 | 4·79 | 4·35 | 5·27 |
| Cwts. of silica from 1 ton of air dry cellulose | 2·15 | 2·98 | 2·56 | 1·12 | 0·40 | 1·08 |
| Cwts. of 60 per cent. alkali ($Na_2O$) required to form $Na_2SiO_3$ with the total silica. | 3·70 | 5 11 | 4·39 | 1·93 | 1·02 | 1·85 |

* Air dry cellulose containing 10 per cent. of moisture. Air dry straw containing moisture as shown above.

It is not very difficult to classify the straws according to the nature of the fiber or cellulose they yield, although such a classification as I am about to attempt is true only locally. My experience being confined to Dutch straws, the following bears directly on them:

*Barley straw* yields a short, very soft fiber of low felting power. The knots and husks are soft, and in consequence this kind of straw is easily digested.

*Oat straw* is usually somewhat harder; the knots and husks are more difficult to digest. The fibers it yields are comparatively long, soft, and of medium felting power.

*Wheat and rye straw* are, according to my experience, closely allied. They both yield long fibers of good felting power, and are the most valuable as sources of cellulose. Rye straw in particular yields cellulose of excellent quality, and as it usually contains a comparatively small quantity of mineral matter, it is soft and easily digested.

The classification of these particular straws grown in other countries would doubtless be different, because the amount of ash they contain controls to a large extent the facility with which they are converted into cellulose.

The composition of these straws, according to Muller, an oft-quoted authority, also varies enormously. His analyses, which I reproduce, plainly show this:

Composition of Straws (Muller)

| | Winter Rye. | Winter Wheat. | Summer Barley | Winter Barley. | Oats. |
|---|---|---|---|---|---|
| Water | Per Cent 14 3 | Per Cent 14·3 | Per Cent. 14·3 | Per Cent 14·3 | Per Cent. 14·3 |
| Organic constituents | 82·5 | 80·2 | 79·7 | 80·2 | 80·7 |
| Ash | 3·2 | 5·5 | [illegible] | 5·5 | 5·0 |
| Fat and wax | 1·3 | 1·5 | 1·4 | 1·4 | 2·0 |
| Nitrogenous bodies | 1·5 | 2·0 | 3·0 | 2·0 | 2·5 |
| Starch, gum, &c. | 25·7 | 28·7 | 31·3 | 28·4 | 36·2 |
| Cellulose | 54·0 | 48·0 | 43·0 | 48·4 | 40·0 |
| Per cent. of dry cellulose on dry straw | 63·0 | 56·0 | 50·1 | 56·4 | 46·6 |
| *Per cent. air dry cellulose on air dry straw | 60·0 | 53·3 | 47·7 | 53·7 | 44·4 |

* Air dry cellulose containing 10 per cent. of moisture. Air dry straw containing 14·3 per cent. of moisture.

The estimation of the cellulose in fibrous plants by the method recommended by Muller is a long, tedious process, and is difficult to perform with accuracy in the laboratory. In my opinion it is uncertain, and requires experience and the exercise of great care in order to obtain concordant results. Few paper or pulp makers will believe that the percentage of cellulose obtained by him in some of the above examples really represents the truth. Some of them, according to my experience and researches, are unquestionably high, and cannot be taken as representative of the class of straw to which they relate. Although it is impossible to assign a definite percentage of cellulose to any one class of straw, yet practical manufacturing yields are fairly constant, and it is very probable that Muller has included other organic matters closely allied to cellulose in the percentages given under this heading in his table.

It is manifest that a process is required for quickly estimating the cellulose available for paper making in fibrous plants, especially one that will be fairly accurate and yield results more surely indicating the yield it is possible to get in manufacturing practice. It is well known that weak aqueous solutions of bisulphites of soda, lime, or magnesia, at moderately high temperatures, do not dissolve cellulose so readily as solutions of caustic soda, if indeed they can be said to dissolve cellulose at all. The method of estimating the cellulose in this way seemed to me to yield much more satisfactory results than Muller's method, and I have used it for many years for ascertaining the amount of cellulose in a great variety of fibrous plants and other kinds of paper stock. By digesting a known weight of the plant, etc., in an aqueous solution of bisulphite of soda, lime or magnesia, and after washing, bleaching, and drying, making an allowance for the mineral matter in the pulp, the percentage of cellulose may be readily calculated. This method yields results invariably much lower than Muller's figures, and very closely resembling manufacturing yields, and therefore I believe more truly represents the cellulose available for paper-making purposes. Some of the results obtained by this method are the following, viz.:

It will be noticed in both of these tables of analyses that the percentage of oven dry cellulose in the oven dry straw has been calculated in each case for comparison, and that the descending order in which the straws indicated yield in my own table is as follows, viz.: Rye, oat, wheat (average), and finally barley. On the other hand, the order, according to Muller's table, is different: rye, wheat, barley, and oat. If the results from both tables be compared, the difference between the percentages given for each class of straw is so great that, as I have previously stated, the experienced pulp or paper maker would decline to accept Muller's results as representing the truth. Of course, I am well aware that this depends entirely on what one calls "cellulose." If the organic intercellular matter, insoluble in ether, benzol, and ammoniacal water, which binds the individual fibers together in the plant can be considered as cellulose, then Muller's figures are no doubt correct. On the other hand, this intercellular organic matter appears to offer little resistance to the solvent action of weak caustic alkalies and bisulphites, and certainly from a paper maker's point of view, cannot be considered as available for his use.

### II.—*Manufacturing Operations.*

(*A.*) *Cleaning.*—The straw as it is brought from the stacks or store house is first of all passed through a machine to thoroughly open it; or this may be done by hand. It is then delivered or placed upon tables made of wire gauze, ¼ in. meshes, alongside of which girls stand whose duty it is to remove all weeds and other plants likely to produce what is known as shieve, in the finished pulp. From these tables it is elevated either automatically or by hand to the cutter, which usually consists of an ordinary chaff cutter used by farmers. The straw is fed continuously by an endless traveling belt through an orifice across the face of which, at right angles to the feed, a wheel revolves, having one or more knives attached to its spokes. The length of cut varies from ⅛ in. to 1½ in. From this the chaff falls on to an inclined jogging sieve of ⅛ in. wire gauze, and in traveling to the lower end the bulk of the sand, husks, and fruit grains are separated. Although the chaff at this stage is tolerably well cleaned, some manufacturers prefer to give it a final dusting, and to do this they employ a revolving sieve, through the center of which a shaft revolves at a high velocity. This shaft has pegs studded along its length at equal intervals, and so placed as to form a kind of archime-

* From the *Journal of the Society of Chemical Industry.*

dean screw. The sieve is cone-shaped or slightly inclined, and as the chaff travels forward, all loose dust is separated, being carried through the meshes by the current of air induced by the revolving shaft. It is then stored in heaps ready for the pulp boilers.

The object in subjecting the straw to such a trenchant system of cleaning as above indicated is to remove all foreign weeds, husks, fruit grains, and sand. This is absolutely necessary for the production of high class pulp, for it has been found by experience that these impurities produce more or less unbleachable particles, and much of the success attained in avoiding these imperfections depends on the completeness and care with which the straw is primarily cleaned before it enters the pulp boilers. The loss incurred by cleaning will depend upon the quality of the straw, but it should not exceed 5 per cent. of the total weight operated on.

(*B.*) *Digesting the Straw in Caustic Soda Lye.*—The boilers usually employed for doing this are of the rotary type, either cylindrical or spherical. Very seldom are upright stationary boilers used. The reason of this seems to lie in the necessity of keeping the mass within the boiler in a continual state of motion, so that each particle of straw will be equally acted upon by the caustic lye. This cannot very well be attained in stationary boilers, even with the usual vomiting arrangement, because the chaff, when softened by the lye, sinks down into such a dense solid mass as to interfere with the free circulation of the lye through it.

Of the two rotary boilers mentioned, the spherical type offers certain advantages over the other. It occupies relatively less floor space, is more easily filled and emptied, and presents less radiating surface per unit of capacity. These boilers are usually provided with two man holes, a blow-off cock, etc., and are heated by steam injected through the trunnion. Motion is given to them by means of worm gearing fixed to the standards supporting the boiler.

The strength and volume of the caustic lye employed necessarily vary in different mills, according to the kind of straw used and upon other conditions peculiar to the nature of the apparatus in use, *e. g.*, the steam arrangements of the factory. Both are slightly modified when barley straw is used alone, but as in actual practice the best results are obtained by mixing the different kinds of straw and keeping the mixture as nearly as possible constant, any rule laid down with respect to the proportion of caustic lye required is adhered to from day to day. The actual quantity of caustic soda, reckoned as 60 per cent. alkali, also varies slightly with different kinds of straw, as well as on the temperature and speed with which the digesting operation is carried out. Where the temperature is high and the time given for the boiling is long, the caustic is reduced to a minimum.

The following figures, representing the "charge," etc., of a straw pulp boiler, are from actual practice:

| | |
|---|---|
| Weight of straw (mixture of oat and wheat) | 4,480 lb. (40 cwts.) |
| Gallons of caustic lye | 1,610 |
| Hours under steam pressure | 4 |
| Steam pressure above atmosphere | 60 per sq. in. |
| Maximum temperature | 307° Fah. |

CAUSTIC LYE.

| | |
|---|---|
| Twaddell | 10½° |
| Total weight in pounds | 16,945 |
| Percentage by volume of $Na_2O$ | 0·3249 |
| " " 60 per cent. alkali | 0·5416 |
| Total 60 per cent. caustic soda in pound | 872 |

Pounds of 60 per cent. caustic alkali on 1 cwt. of straw = 21·8.

The operation of digestion is very simple. The pulp boiler is filled as full as possible with the cut and cleaned chaff and the required volume of caustic lye run in. The manlid door is then put on and a small quantity of steam admitted, while the boiler is made to revolve for 15 minutes or so in order to soften the straw and cause it to subside to make room for more. When this is done the lid is again removed and the vacant space within the boiler filled up with more straw. In this way the charge of straw per boiler is increased from 15 to 20 per cent. When the boiler is thus filled and the manlid fastened on, high pressure steam is injected into the charge through the trunnion, and the pressure gradually raised to the desired degree. The pressure varies in different mills, but as a rule it registers from 60 to 90 lb. per square inch. This pressure is reached after about two hours' steaming, and is further maintained for 4 or 4½ hours. In the meantime the boiler is kept continually revolving.

(*C.*) *Washing, Breaking, Purifying, and Bleaching the Straw.*—After the digesting operation has been completed, the whole contents of the boiler are emptied into a tank placed beneath it, where the crude cellulose is washed with hot water. It is necessary to accomplish this work with the least possible quantity of water, in order to avoid undue dilution of the waste lye. The most efficient method is that of the application of the principle of displacement as carried out in the lixiviating of ball soda in the Leblanc soda process. It is possible in manufacturing practice to remove 95 per cent. of the soda associated with the boiled straw cellulose by this system of washing with a dilution of about one-third, that is to say, that pulp can be washed in the tanks with a quantity of water represented by one-third of the volume of black lye associated with the pulp. The weakest washings from these vats are run to waste, as it does not pay to evaporate them, even although the most refined system of evaporation be used for their concentration.

After the bulk of the black soda lye has been removed in the way described, the crude cellulose is allowed to drain, and then conveyed to an apparatus called a "breaking engine," in which it is broken into pulp.

In this engine it is again washed to remove the last traces of soda; and a proportion of the intercellular matter surrounding the fibers, as well as any dirt, will pass away with the wash water. That part of the intercellular matter carried away is in a fine state of division, and if it be left in the pulp, it is supposed to consume a large quantity of bleaching powder in the subsequent bleaching. As a matter of fact, however, if the straw be properly boiled in the first instance, the intercellular matter has little influence on the amount of bleach required to bleach unit weight of crude product. It is possible to wash straw pulp in the breaking engine to such an extent as to seriously affect the yield of pulp, and therefore the bulk of the washing can be most advantageously done in the tanks.

The pulp, although now broken up, so that the fibers are separated from one another, is not yet in a fit state of purity to be bleached. It invariably contains a few unboiled pieces of straw, or possibly some unboiled knots or hard weeds, and it is absolutely necessary to separate these to get a clean product. In order, therefore, to cleanse it, the contents of the breaking engine are emptied into a large tank, and pumped into special purifying apparatus. This apparatus consists of a long shoot, called a sand trap, as a rule about 200 feet or more in length, about 18 in. wide and 9 in. deep, containing, at intervals of 18 in. or so, cross boards about 4 in. high, and inclined toward the flow of the pulp. At the end of this sand trap, a series of cast iron boxes, called strainers, are placed. These strainers contain brass plates, having very fine slits cut in them, and it is through these slits that the individual fibers pass, while the rough, hard, unboiled pieces are retained. After the pulp passes through these slits, it is practically pure and clean. The width of slit of course regulates to a certain extent the degree of purification required.

The pulp before entering this apparatus is largely diluted with water to enable the particles of sand, dirt, and heavy weeds to subside as the mixture flows over the submerged cross boards. Any impurities which pass the sand trap are retained by the strainer plates.

It is now necessary to remove the large excess of water from the cellulose before bleaching, and this is done in a variety of ways, one of the best being by means of a machine called a "tambour." This is simply a skeleton cone made of hard wood and covered inside with fine brass wire gauze. The whole is mounted on a horizontal shaft running through its center, and as the pulp flows into the narrow end, as it revolves, the water passes through the wire gauze, while the pulp is discharged from the wide end, in a concentrated state, into a reservoir, from whence it is pumped into the "potcher."

The "potcher" is constructed on the same principle as the "breaking engines," but as the name implies, is used simply as a mixing machine. When full, a certain volume of a clear solution of bleaching powder is added, and the stirring continued for an hour or two, when the whole charge is run off into large concrete tanks, fitted with false bottoms of perforated tiles. In these tanks the mixture of pulp and bleach liquor is allowed to remain for 12 or 16 hours, by which time the hypochlorite will be exhausted, and the pulp of a white color.

It is only necessary to allow the spent bleach liquor to drain away, by drawing a plug from its seating in the bottom of the tank, and then removing the cellulose to another tank, where it is mixed with clean water, and finally pumped on to the paper machine, by which it is converted into a thick sheet of paper, in which state it is sold.

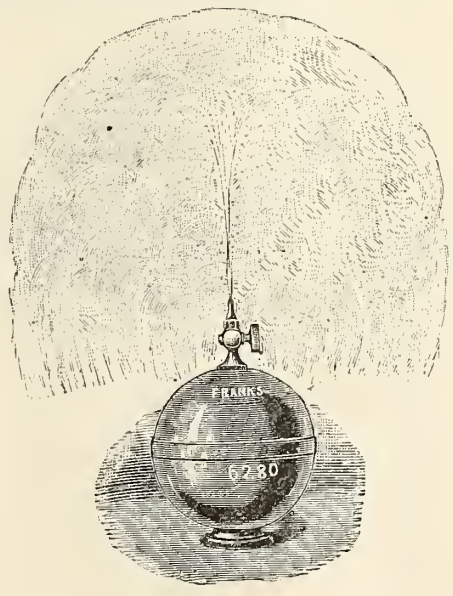
The foregoing in effect embraces the routine of this manufacture. The apparatus, both in arrangement and detail, is modified in different mills. The operations are simple, and require no great skill to carry them on successfully, but the chemical problems involved in the economical production of straw cellulose are more difficult to deal with, and I now propose to touch upon the most important of them.

(*To be continued.*)

## SELF-ACTING SPRAYING DEVICE.

AT Messrs. C. & S. Frank's office, 25 Aldermanbury, E. C., London, a simple but ingenious contrivance may be seen, which will be found of considerable use to pharmacists, so says *The Chemist and Druggist.* Mr. Frank describes his invention as a "water-pressure accumulator," and our illustration shows it at work.

The accumulator is a metal globe, with an aperture at the top by which it is filled. If held under a tap, and closed rapidly when filled, it retains not only the water, but the greater part of the air with which the fluid is mixed, according to the amount of pressure behind it. A mouthpiece is then screwed to the bowl




(these mouthpieces are obtainable in various sizes and shapes), and the tap turned on, when a spray or jet, varying in height and intensity, will be produced, which in a gallon apparatus will last for about half an hour. The spray is produced by the air in the bowl, which the inflowing water compresses at the top, expanding as soon as the tap is turned on, and expelling the water. To effect this purpose a tube has been fitted inside the bowl, leading from its upper part to within a short space of the bottom, which is the only exit of the compressed air.

The bottom part of the bowl can be unscrewed to remove the residual water and to introduce scent or other substances which it is desired to distribute. To chemists the "accumulator" should be particularly useful for perfuming ballrooms and other apartments, and as a disinfector. By using mouthpieces of various kinds, the apparatus may be made to do service as a toilet douche, an ear or throat spray, a fountain, etc.

Our second illustration shows the manner of filling the accumulator at the tap. A rubber-topped ring is screwed lightly to the neck of the globe, and connected with the tap. When the sound of the inflowing

water ceases, the globe tap first and then the water tap should be closed, and the accumulator disconnected.

## COAL TAR PITCH: ITS USES AND FUTURE MARKET.*

By R. WATT.

COAL tar pitch twenty-five years ago was comparatively a new factor in the commercial world. It was almost unknown. Whenever pitch was mentioned, the mind of the merchant or manufacturer reverted to the pine tar product of North and South Carolina. Even the gas companies of the United States were ignorant of the commercial value of tar. Instead of turning it into a source of revenue, their main object was to dispose of it in a way that should not pollute the rivers or streams near their works, and cause a public nuisance. Consequently they wasted millions of gallons of tar, which, if turned into pitch and the avenues of uses had been opened to it, would have largely augmented their revenues. As a result of this lack of foresight, consumers not being educated in its uses, they were limited to the use of pine tar pitch and resin for roofing, and other purposes.

When pitch was placed on the free list, foreign pitch was reduced in price and came into general use in this country, largely owing to its cheapness; but it was often of such poor quality that it was unavailable for many of the functions of pitch. The cause of this poorness was obvious. Foreign producers, who were also little instructed in the advantages of pitch in its various lines, did not regard their product of much importance, and thought that anything would suit so long as it was called pitch. They distilled the tar mainly for the resultant oils and chemicals, and pitch with them was only a by-product of many impurities. It was usually hard and brittle, and contained many foreign substances which were detrimental to its utility. Its importation, however, brought pitch into more general use by reducing the price of what pitch was manufactured in this country.

Now, while this result curtailed the revenues of the gas companies engaged in the production of coal tar, it also stimulated them into better appreciation of the commercial worth of the product. The tar distillers revised their methods of manufacture, and sought to meet the necessities of the growing market. Instead of treating pitch as a by-product, as many of their European competitors still do, they now distilled the tar solely for the pitch; and looked upon the resultant oils and chemicals as the by-products of secondary interest from a commercial point of view. Owing to this change of front on the part of the distillers, the coal tar pitch of the United States takes first rank in the market. It is free from the impurities of the imported article, and therefore better adapted for the various purposes for which coal tar pitch is now used.

In this brief paper I need only call attention to a few of the leading uses of coal tar pitch. For roofing purposes it is unsurpassed, and is in general vogue in all our large cities. Its superiority over tin and iron roofs is everywhere admitted.

During the past fifteen years it has become the principal factor in nearly all the prepared roofing on the market. A combination of pitch and felt resists the action of water much longer and is more durable than any other class of roofing material; and, what is of equal importance, the cost of such roofing is one-third less than roofs of tin or iron. It, moreover, makes a much safer roof in the case of fire. While the metal roofs disjoint and fall to pieces from the action of heat, and thereby add to the intensity of the fire, pitch roofs fall down bodily and tend to smother out the flames, and in this respect effect a much quicker result than thousands of gallons of water.

In street paving the advantages of pitch have frequently been demonstrated. In many cities specifications call for from 10 to 20 per cent. of refined Trinidad asphalt, added to the pitch or cement employed in paving; but this clause is rarely complied with. Practical men know that the addition of this asphalt is more of a detriment than a benefit to the pavement, and they condemn and reject it, even when set forth in the specifications. City authorities, as well as contractors, know that block stone pavements are not satisfactory or durable; unless pitch has been used for filling the crevices or cementing the blocks together. Years of costly experiments were needed, in many instances, to substantiate this fact; but to-day pitch filling is regarded of the utmost importance; since pavements so treated are more lasting and less subject to ravages of water than those which have been laid without pitch as cement and filler. Indeed, pitch pavements are practically impervious to water, and accordingly escape its corrosive or undermining effects.

In Eastern, Central, or Southern cities, where brick

* Read at the tenth annual meeting of the Ohio Gas Light Association, at Columbus, O., March 21 and 22, 1894.

pavements have largely superseded all other styles, it has been proved that without a pitch filling, such pavements are like leafy roofs in wet weather. The rain percolates through the crevices and injures the foundation, rendering repairs necessary in a very short time. Pitch, on the other hand, prevents the bricks from absorbing moisture, effectually seals up the joints, and keeps the pavement firm and intact. Should the pavement sink from any cause, the points of fracture join naturally together again; whereas, with hydraulic cement or mineral grout of any kind, breaks and cracks are hard to repair, and pavements so laid soon present a ragged and uneven surface.

Coal tar pitch was extensively used for the vulcanite asphalt pavements in Washington, D. C., which was admitted to be the finest in the country. A recent estimate shows that 1,500,000 yards of asphalt and 500,000 yards of vulcanite have been laid in that city with pitch or coal tar distillate; and in all instances where the proper ingredients or proportions have been used, the results have been in the highest degree satisfactory. Pitch is also used to excellent purpose in floorings of establishments where there is much moisture. Where oils or acids are liable to fall, an asphalt floor laid with pitch is superior to asphaltum alone. Petroleum softens asphalt, but it has no effect whatever on a floor of coal tar pitch. These facts have been recognized in numerous cities. In Pittsburg fully 80 per cent. of the asphalt pavements have been laid with pitch, with splendid results.

But there are other and equally important avenues for the employment of coal tar pitch. It enters extensively into the manufacture of carbons for electric lighting. Various substitutes for pitch have been tried, but none have thus far proved successful. In Germany it is used in the manufacture of pipes for the conveyance of cold acids in chemical works, and also for lining acid holders. Underground pipes for gas or water are coated with pitch to prevent rust or corrosion. Boat bottoms are pitched to preserve the timber and give a smooth surface. The wooden pipes, manufactured in Michigan and New York, are made more useful and durable by their pitch coating.

Another important use for coal tar pitch has been found in the manufacture of egglette coal, the new fuel which bids fair to revolutionize the market. This fuel is made of hard and soft coal dust, mixed with 10 per cent. of pitch, and pressed into egg-shaped pieces. Its popularity for family and manufacturing purposes is already so pronounced that factories for its production are contemplated in various sections. This industry will undoubtedly give great impetus to the pitch market. Even the dust and screenings of the mines can be converted into as valuable a fuel as hard coal, while many grades of Western coal can be rendered bituminous by the use of pitch as a binder. All the indications are that the demand for the new fuel will go on increasing. In England its manufacture and sale has already reached large proportions, and egglette has given great satisfaction whenever tried.

Owing to the manufacture of gas from petroleum products, of late years the supply of coal tar has diminished. A quantity of pitch obtained from gas tar derived from petroleum products has been used for paving and roofing purposes; but the large percentage of water in the tar has rendered it very difficult to handle. While the pitch made from this tar is not as good as genuine coal tar pitch, yet the cheapness of the tar has forced it into the market as a substitute for many purposes, with fair success.

The expanding market, as well as the revenue from the production of pitch, ought to stimulate the production of coal tar, and tend to the diminution of gas making from petroleum. When the gas companies fully realize the conditions of the market, they will no doubt govern themselves to meet those conditions in the most profitable manner. Besides those already referred to, there are hundreds of avenues, some of them individually small, but large in the aggregate, for the consumption of pitch. Indeed, taken altogether, the outlook for this valuable product of coal tar is very promising. With the increasing demand for felt roofing, the growing popularity of brick for paving, where pitch will in time be universally used for filling, the employment of granite block for paving with pitch filling, the extension of electric light, causing a larger demand for carbons, and the expanding consumption of the new fuel, to say nothing of the many minor avenues of use, the producers of coal tar pitch certainly have every reason to expect a bright and profitable market.

## THERMOSTATIC REGULATORS FOR INCUBATORS AND OTHER HEAT APPLIANCES.

By G. D. HISCOX, M.E.

IN answer to the many inquiries in regard to the construction of thermostatic bars, heat regulators and ventilators for incubators and other purposes, we illustrate such as we have tested for reliability, and of a construction within the means of most amateurs.

The materials that possess a large range of motion for each degree of change in temperature are somewhat limited, and, with the best, its range requires to be multiplied for effective work.

Among the metals, zinc has the largest range, equal to 0·0002 of an inch per foot in length for each degree F. of change of temperature. This being too small for the direct movement of a zinc rod, even when multiplied by a lever system, in order to utilize it to the best advantage the zinc rod may be fastened to a strip of thin steel which has a movement of only 0·00007 of an inch per foot in length for each degree of change in temperature, and thus multiply its range by differential expansion and lateral motion as shown at A, Fig. 1. The strip of zinc may be cut from rolled sheet zinc No. 16, not less than 2 feet in length clear of fastenings, 2 inches wide at the butt end, tapering to ½ inch at the free end. The strip of steel No. 20, or if steel cannot be easily procured, a strip of Russia sheet iron will be nearly equal, having a slightly higher expansive property, may be cut of the same form as the zinc, but slightly longer for making the damper connection as shown in the cut. The strips should be riveted together with soft copper wire 1-16 of an inch diameter, headed lightly and only sufficiently to hold the strips together. The lever and bell crank connections with the damper should be made very light and with an adjusting screw and nuts as shown.

The lateral motion that should be obtained in a clear length of 2 feet, for the free end, is ⅛ of an inch for each degree or ¾ of an inch for the full range of 6 degrees for an incubator.

Another combination as shown at B, Fig. 1, may be made with a strip of hard rubber which has a range five times greater than zinc, or equal to 0·001 of an inch per foot in length for each degree of change of temperature. It will not have a proportionally large range, because it must be made of thicker material in order to give the bar the proper stiffness of motion. A combination of a hard rubber strip ¼ inch thick, 1 inch wide, or if convenient wider at the butt, as in the first named arrangement, with a piece of sheet steel, Russia iron No. 20, or a strip of heart hickory ⅛ in. thick, will give a strong motion and a range of nearly ¼ inch for each degree of change of temperature in a bar 2½ feet long clear of fastenings.

The volute coiled thermostat, Fig. 2, is a very compact form, although a little more difficult to make.

The strips of steel or iron and zinc are to be made as in Fig. 1, and may be 2½ feet long Instead of riveting the strips together, they should be cleaned on the faces that are to be united and tinned with pure tin by a soldering copper; then placed together, bound with strips of wood and the edges united by melting the tin with a hot soldering copper. Any tinsmith can make a neat piece of work in this line. It can then be bent in the form as shown, and the butt end screwed to a wooden stud, or soldered to a metal bracket.

The manner of connecting the spring with the lamp and warm air flue is plainly shown in the cut, subject to any modification required by the position of the lamp and the thermostatic coil. The connecting rods, C and D, have a running thread and two nuts on each

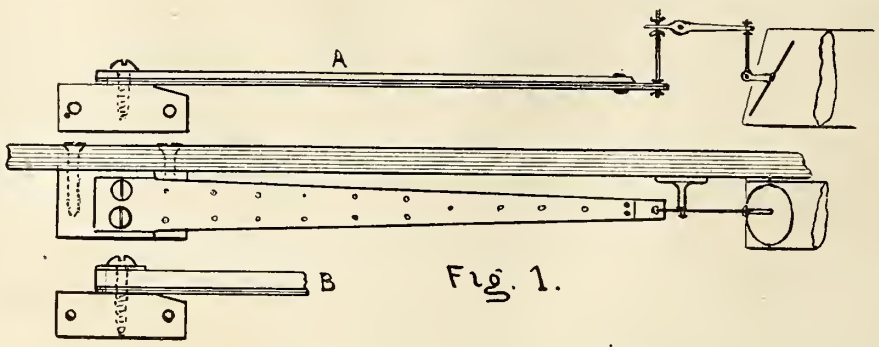


Fig. 1.

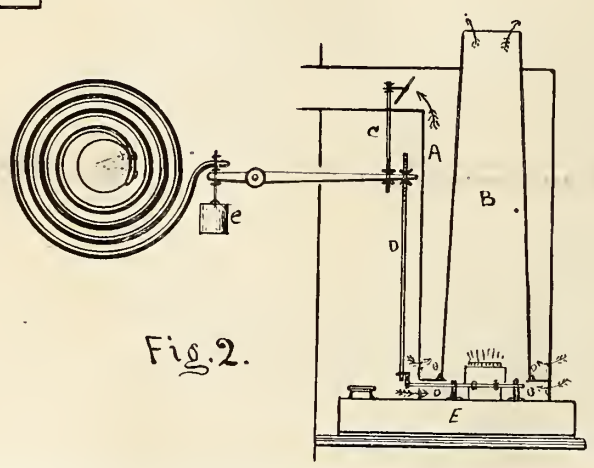


Fig. 2.

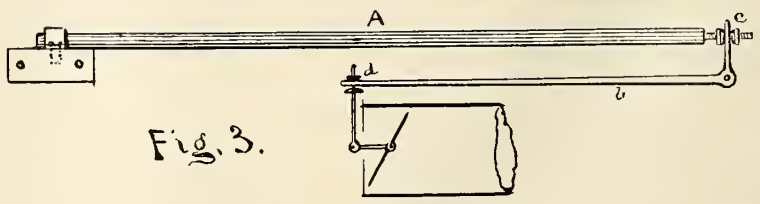


Fig. 3.

THERMOSTATIC REGULATORS.

for adjustment of the air valve and lamp flame; the latter being operated by a sleeve sliding loosely over the wick tube and operated by a bell crank shaft so as to cover the wick without moving it in the wick tube. The lamp chimney, B, should be made of thin copper for the best transmission of heat, and the warm air chamber, A, may be made of tin. The counterbalance weight, E, may not be needed if care is taken to otherwise balance all the moving parts.

The round rod of hard rubber is also in use for thermostats, as shown in Fig. 3. Such a rod should be ⅝ inch in diameter by 3 feet in length, and will have a temperature variation of 1-40 of an inch for 6 degrees, by multiplying which by a delicately arranged bell crank with adjusting screws as shown in Fig. 3, the warm air throttle and burner sleeve will receive the proper amount of motion for regulating the temperature of an incubator.

The rods and strips of hard rubber are kept in stock by the makers of hard rubber goods, and may be obtained through the rubber trade.

Other constructions of thermostatic regulators are in vogue, such as a long brass wire, about No. 30 wire gauge, wound around a series of small grooved wheels set some distance apart on a wooden frame, but as brass wire only varies 0·0125 of an inch per 100 feet for each degree change of temperature, or 0·075 of an inch for 6 degrees, it is not suitable for the purposes of an incubator. A flat hollow disk of hard brass with concentric corrugations, half filled with sulphuric ether and hermetically sealed with solder, has a large range of movement. The ether boiling at from 98° to 105° Fah., according to its purity, and thus generating a slight pressure above its normal vapor pressure near its boiling point has also been used. It is of too inflammable a nature to be recommended for amateur use.

## A NEW TRANSATLANTIC CABLE.

ON August 16, 1858, at twelve minutes past eleven in the morning, telegraphic communication between the Old and the New Worlds was inaugurated by the following dispatch sent fron Valentia to Newfoundland:

"Directors Atlantic Telegraph Company, Great Britain, to directors in America. Europe and America are united by telegraph. Glory to God in the highest; on earth peace, good will toward men." On September 1 following, however, the cable ceased to work, having, during the twenty-three days, conveyed 400 telegrams of 4,359 words and 21,421 letters. It was not until July 28, 1866, that telegraphic communication was again restored between the two continents by a new cable, and from that date the Anglo-American Company had no rival until August 15, 1869, when the French Atlantic Company's cable began operations. The competition thus commenced brought the tariff of both companies down from £1 a word to £1 10s. for ten words. Further competition was avoided by combination. Somewhat similar arrangements followed later attempts at competition. Thus, in 1874, the Direct United States Company entered the field, brought down the rates, and finally, in 1877, was forced into combination. In 1879 the French "Pouyer Quertier" cable was laid, and in the following year entered into a joint purse arrangement. Then, in 1881 and 1882, the two Western Union (Gould) cables were laid, and in the following year also joined the combination.

The next competition which the old company had to face was of a different character to the former attempts, the capital for the new cable being practically supplied by Mr. Mackay, the "Bonanza King" of California, and Mr. Bennett, the well-known proprietor of the *New York Herald*. These enterprising gentlemen in 1883 organized the Commercial Cable Company, and have since maintained the independence of their undertaking. The competitors have wisely given up a "war of rates," and content themselves with energetic and determined attempts to secure a fair share of that transatlantic cable business which has so far kept the companies' lines fully employed. The competition for business thus insured, together with the natural development of international relations, has, indeed, caused such an increase in the daily telegraphic correspondence between this country and America that the Anglo-American and Commercial companies have found it necessary to lay new cables. The Commercial Company in this race are slightly ahead of their rivals, and their steamer with the two shore ends started recently. Since the last cable was laid in 1884 experience and scientific research have indicated directions in which the old cables might be improved, and the new lines of the Commercial and Anglo-American companies, it is safe to say, will be far ahead of the old ones in carrying capacity, durability, and in other respects.

Messrs. Siemens Brothers & Co., Limited, laid the two cables of the Commercial Company, and naturally, therefore, secured the contract for the new Mackay-Bennett line. The headquarters of Messrs. Siemens are in one of the fine old mansions at Queen Anne's Gate, Westminster, and our representative, who called for particulars concerning this new link of communication with our transatlantic cousins, found Mr. Alexander Siemens in one of those delightful rooms overlooking St. James's Park which make the rush and hurry of these latter days appear strangely out of place, and unsatisfying.

A visit to the company's great works at Woolwich, with their electrical appliances, steam hammers, and all the other adjuncts of a mighty workshop, brings one back, however, from the old world memories of

Queen Anne's Gate to the hard realities of to-day. A submarine cable consists first of a core, which comprises the conductor, made of a strand of copper wires, and the insulating covering, generally made of gutta percha, but occasionally of India rubber, to prevent the escape of electricity. Then comes a layer of tanned jute yarn laid over the gutta percha to protect it from the sheathing of steel wires, over which come again jute yarn and a bituminous compound. The sheathing varies in type, Mr, Siemens explained, with the depth of water in which the cable is to be laid. This sheathing may consist of as many as seven types, increasing in strength and protective power as the shallow water is approached. The core is the same throughout.

### HOW THE CABLE IS MADE.

The copper wires for the conductor are twisted up together or stranded; they are then passed through the covering machine, by which the gutta percha is squeezed round the conductor in a continuous envelope touching it throughout. The core is then served with jute yarns, which are laid spirally round it, forming an elastic soft bedding for the sheathing wires. These latter, as well as the outer serving and compound, are put on in one machine. The served core passes through the hollow shaft of a circular skeleton framework of iron, on which are mounted bobbins filled with steel wire or jute yarn, as the case may be. This framework can be rotated, and the cable being at the same time drawn along, the wires or yarns are wound spirally round the core. The bituminous compound is applied by the cable being passed under a spout from which the melted compound runs. The finished cable is then coiled in large circular iron tanks, in which it is kept under water.

### HOW THE CABLE IS LAID.

The cable ship is fitted with similar tanks in the hold, and the cable is coiled away in them, being drawn out of the land tanks. When the ship is at sea, the cable runs out over a large pulley at the stern of the ship, having to pass on its way from the tank over and under several retarding wheels, then round a large brake-wheel, by means of which the speed at which it runs out can be regulated; and then under a dynamometer, the object of which is to indicate the amount of strain to which the cable is subjected at any moment, and also to enable the man in charge of the brake-wheel to regulate the amount of strain put on by the brake to suit the varying conditions of laying. When all the available cable has been laid, the end is carefully sealed up, and having been attached to a rope, is lowered to the bed of the ocean; a buoy is attached to the other end of the rope, and is left floating on the surface of the water to mark the position of the end of the cable. During the whole time that the cable is being manufactured and laid electrical tests are continuously taken, so as to make sure that everything is in order.

There are at present ten Atlantic cables, and two more will, as above stated, be laid this year. Of these twelve cables, seven will have been made and laid by Messrs. Siemens Brothers & Co.

In 1875 Messrs. Siemens Brothers & Co. laid the direct United States cable, in 1879 the French cable, in 1881 the northern Western Union Cable, in 1882 the southern Western Union cable, and in 1884 two cables for the Commercial Cable Company. This company having decided to lay a third cable, the order for it was placed with Messrs. Siemens Brothers & Co. on November 21 last, and the manufacture was at once started at their works at Woolwich, so as to have it completed in good time for laying during the favorable season. The rate of manufacture has been unusually rapid, being, for the deep sea type, more than five nautical miles (a nautical mile = 2,029 yards) per machine in twenty-four hours (the manufacture is carried on continuously day and night); and there being ten cable machines at the factory, from 50 to 55 nautical miles of deep sea cable can be turned out in every twenty-four hours. The new commercial cable will have a much greater weight of conductor and of gutta percha than any of those previously laid, and in consequence the speed of signaling through the new cable will, Mr. Siemens maintains, be at least one-third faster than the speed on either of the former cables made by his firm for the Commercial Cable Company. A few years ago such a fast cable would not have been worked up to its full message carrying capacity, because the ordinary telegraph operator could not have manipulated his apparatus fast enough by hand. But the Commercial Company now employ automatic sending apparatus which enables them to attain a high speed, while insuring accuracy. The following are the weights of material used in the manufacture of this third commercial cable, which is in all 2,201 nautical miles in length: Copper wire, 495 tons; gutta percha, 315 tons; jute yarn, 575 tons; steel wire, 3,000 tons; compound and tar, 1,075 tons; total, 5,460 tons.

The laying of the cable will be done by the telegraph ship Faraday, belonging to Siemens Brothers & Co., and specially designed by the late Sir William Siemens for cable work. The cable is stored on board in three large tanks, two of them being 45 ft. in diameter and 30 ft. deep. The three tanks together are capable of holding 1,700 miles of cable. The laying will be done in two expeditions: the first has just started, and will comprise the shore ends and intermediate sections—in all about 700 nautical miles. The first section will be laid from Waterville, in Ireland, out into deep water, and the end will then be buoyed. The second section will be laid from Canso, in Nova Scotia, over the Great Bank of Newfoundland into deep water, and this end will then be similarly buoyed. The Faraday will return to Woolwich to take in the cable for the second expedition, which will start in the middle of June, and will comprise the 1,500 nautical miles of deep sea cable. The laying will begin from the buoyed end of the cable laid out from Ireland, and continue across toward America till the buoyed Nova Scotia end is reached, when the final splice will be made, and the cable will be completed throughout. Under favorable circumstances of weather the laying can proceed at the rate of about seven nautical miles an hour, so that the laying of the deep sea section should be completed in about ten days.—*London Daily Graphic.*

## AN ADJUSTABLE MICROPHONE.

By W. H. SOULBY.

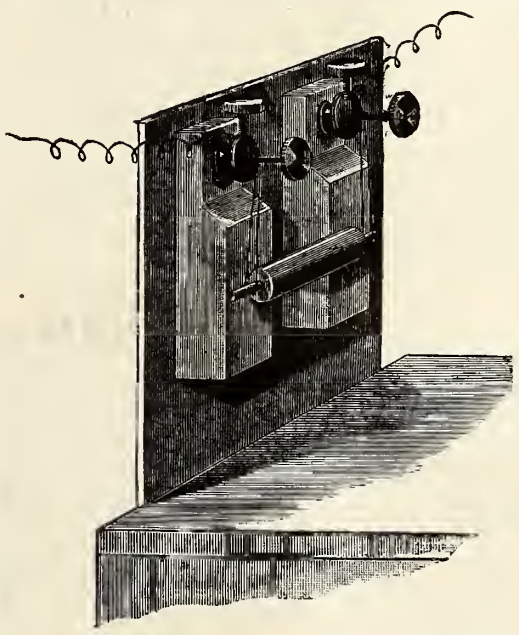
THOUGH no claim is made to novelty in the following apparatus, yet as it appears to possess certain features which have not hitherto been published, and as experience has proved that the facilities for delicate adjustment are very marked, I have been induced to describe the same.

First, as to the arrangement of the carbons, which are fixed to a small sheet of ebonite about 5 in. × 3 in., which again is fixed to the end of a sounding box (a cigar box does duty in the present case). Two blocks of carbon, each 1½ in. long by ½ in. thick, are cut down at one end to form a lip or flange, through which the binding screws pass to fasten the carbons to the ebonite sheet. The vertical screws connect the wires conveying the current. The horizontal screws have each a short length of sewing cotton wrapped around them; a piece about 8 in. long is doubled, the two ends being brought together, are placed on the screw, and wrapped round it, leaving a loop of about one inch long hanging down, at the end of which a noose or slip knot is formed to carry the reduced ends of a small cylinder or pencil of carbon, about 1 in. long, which remains suspended thereby, and can be raised or lowered by a turn of the screws.

This suspended cylinder of carbon just hangs clear of the fixed carbon blocks. The connecting wires are brought into contact, but no current passes until the carbons are made to touch each other. The sounding box is then slowly tilted up (by means of a wedge pushed gradually under the end of it) till the carbon cylinder rests against the fixed blocks, just lightly enough to obtain the best results, which can be ascertained by placing a watch on the sounding box and the receiver to the ear while adjusting.

A further adjustment for the strength of current can be made by altering the relation of the carbon blocks to each other; the binding screws forming a pivot around which they may revolve, when brought closer together more current is allowed to pass, while by separating them it is reduced. This arrangement, therefore, provides two adjustments—one for making the contact or connection, the other for regulating the current.

Secondly, regarding the effects produced. The difficulty in this instance was to obtain sounds of a suitable strength, or pitch, to obtain the best effects from so delicate an instrument. Of course a watch was the first sound-producer tested, and when all was quiet, without any other sound or movement near, it answered very well; but the playing of a piano in one part of the house, and the washing of dishes in another, disturbed everything, including the patience of the experimenter. Upon any one entering the room, walking about, speaking, coughing, touching the table or door handle, the shriek of the receiver was too much to hear; even at a distance its repeated inarticulate cry became most harassing, though only an ordinary receiver was used. After attaching a longer length of double wire, and retiring to a distant room, the sounds still retained their intensity in the receiver, every word spoken in the other room being recognizable when not too loud, and the ticking of the watch was very distinct, even to the metallic ring of the hair spring as it coiled and uncoiled at its work.



A more delicate and exhaustive test was carried on a few evenings later by the help of an assistant. Having adjusted the microphone to the best angle (by the aid of the watch and receiver), the assistant retired to a distant room with the receiver, with instructions to report results. A few words were now spoken near the microphone, but proved too loud to be understood; a lower voice produced the same results; then a whisper; after which, advancing closer to the microphone, a few deep breaths were drawn, and immediately after the first inspiration and expiration the listener called out, "That's splendid! Do it again." A few more respirations were taken, when the listener, coming back from the other room, said, "The breathing sounds very distinct, what a chest you have, and how wonderfully deep and hollow it sounds. A doctor could test people's lungs without leaving his surgery, by getting his patients to breathe near an instrument of this kind; every inspiration and expiration was as deep and clear as possible." A further test was shown by placing the hand or bare forearm on the sounding box, when a rushing sound was heard, which could be none other than the rapid circulation of blood through the veins. It is also a curious sensation to hear one's own voice in the receiver coming from another source than your own mouth.

Some very successful microphones have been constructed, but considering the cheap and simple arrangement of the one described, the results must be considered very satisfactory. The current was supplied by three small Leclanche cells, the receiver being a small adjustable watch telephone.—*The Electrical Review.*

## AN APPARATUS TO SHOW, SIMULTANEOUSLY TO SEVERAL HEARERS, THE BLENDING OF THE SENSATIONS OF INTERRUPTED TONES.*

By ALFRED M. MAYER.

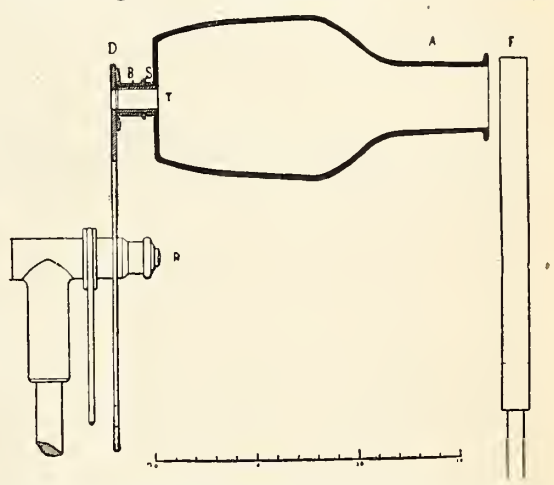
IN the January number of this journal, of the current year, I described several forms of apparatus used in my observations on the frequency of the interruptions of simple sounds required to blend these sounds and obtain from them continuous and uniform sonorous sensations. These experiments gave the data of the law connecting the pitch of a sound with the duration of its residual sensation.

The various apparatus described in that paper are, however, unsuited to exhibit the phenomena to more than one hearer at a time. To enable many hearers to observe simultaneously the phenomena I have devised the apparatus shown in the figure.

A brass tube, T, of 1·25 cm. interior diameter and 1·8 cm. long, is cemented in a hole in the bottom of the glass flask, A, which is a common form of flask, used by chemists. When the tube, T, is closed, the air in the flask resounds powerfully to the sound of an $UT_3$ fork, F; but when this tube is open the resonator resounds so feebly as to be just audible at the distance of several feet from the flask.

If the tube be closed and opened several times in a second, we shall have short loud sounds with faint interposed sounds. The opening and closing of the tube is effected by a perforated disk, D, revolving on a rotator, R. The tube, T, is placed in the circular path of the 16 holes which perforate the disk, with the mouth of the tube quite close to surface of the disk. A short tube, B, with flanges on it, slides neatly over the tube, T, and the flange of B is pressed against the surface of the disk, D, by the helical spring, S. By this arrangement the tube, T, is fully opened when a hole in the disk coincides with the opening of the tube, T, and is entirely closed when the flange of B is between the holes in the disk and gently pressing against its surface.

On slowly rotating the disk, while the fork is kept in vibration by an electromagnet, we have the perception of powerful beats which become more and more frequent as the velocity of rotation of the disk is increased, till, with a certain velocity, the beats blend into a smooth, continuous sound, which is that given by the fork when held near its proper resonator. This sound of $UT_3$ as given by the blending of its interrupted




sound is, however, accompanied by another and graver sound; but the existence of this additional sound does not interfere with the neat perception of the blending of the interrupted sound of $UT_3$. With this apparatus the blending of interrupted sounds has been shown to the entire satisfaction of a large audience.

To enable one readily to make the apparatus the following dimensions are given. The diameter of opening of mouth of flask is 3 cm. Depth of flask 16·25 cm. Capacity of flask, including tube, T, is 483 cu. cm.

In the figure the rotator, R, is shown driven by a cord. It is necessary, if an accurate determination is to be made of the duration of the residual sensation, to drive the disk by gearing as is done in the apparatus I have used. When the disk is driven by a cord one can show the blending of interrupted sounds, but an accurate determination of the duration of the residual sensation is prevented by the friction which exists between the flange of B and the disk, though the surfaces of these are coated with a film of oil.

## ELECTROLYTIC SEPARATIONS.†

THE authors have studied the electrolytic separation of metals in presence of free nitric acid with the following results:

*Mercury from Lead.*—Satisfactory, provided sufficient nitric acid be present.

*Mercury from Lead and Bismuth.*—Unsatisfactory; bismuth was discovered at both poles.

*Silver from Lead.*—Satisfactory.

*Copper from Cadmium.*—Satisfactory.

*Copper from Zinc.*—Satisfactory.

*Copper from Zinc, Cobalt, and Nickel.*—Satisfactory.

*Copper from Iron and Zinc.*—Satisfactory.

*Bismuth from Cadmium.*—Satisfactory; excess of free acid not necessary.

*Bismuth from Zinc.*—Satisfactory.

*Bismuth from Nickel.*—Satisfactory.

*Bismuth from Cobalt.*—Separation possible.

*Bismuth from Zinc, Cobalt and Nickel.*—Unsatisfactory; bismuth always contaminated with cobalt and nickel.

*Bismuth from Cobalt and Nickel.*—Unsatisfactory; bismuth contained nickel.

*Bismuth from Cobalt and Zinc.*—Unsatisfactory:

* From the *American Journal of Science*, April, 1894.

† E. F. Smith and J. B. Moyer, *J. Anal. and Appl. Chem.*, 7, 252-257.

cobalt partially precipitated along with the bismuth. Subsequent experiments showed that the separation of bismuth from cobalt, nickel and zinc was possible, if sufficient nitric acid were present.

In all these experiments the quantities of metal operated on were about a decigramme. The nitric acid (sp. gr. 1·3) added varied about 2 and 30 c. c. The total dilution 170-200 c. c. The strength of current with voltameter and electrolyte in circuit liberated 1·8–0·2 c. c. electrolytic gas per minute.

## SOME FACTS ABOUT FLAGS.

By GUSTAV KOBBE.

THERE never was a more disastrous retreat than that of Napoleon's army from Moscow. Yet there were but few French "colors" among the spoils gathered by the Russians on the steppes where "General Winter," as one of the Czars grimly called the icy blasts which laid low the French veterans of many campaigns, spared a mere remnant of the great army. For the color guards were most touchingly faithful to their sacred trusts. When these men, who had faced unflinchingly many a storm of bullets, saw death by cold and hunger staring them in the face, they tore the colors from the staffs, made a fire with the latter, burned the colors, mixed the ashes with the water of melted snow, drank them, and lay down to die. Many a color guard was found frozen stiff. But where were the colors? Saved from the enemy!

The colors are not merely so many yards of silk. They represent to a soldier what is noblest in his country's history and institutions. Their loss, under circumstances short of heroic, is an eternal disgrace to the regiment losing them. Only death can excuse the color guard from defending them; and when the guard has been shot or cut down, others should be ready to stand by the flag. In the navy a vessel never strikes her colors except to acknowledge a defeat. For this reason, when, in that great sea duel between Paul Jones' Bonhomme Richard and the English Serapis, which lasted far into the night, the ensign was shot away from the halliards, Lieutenant Stafford plunged into the sea after it, and, braving a double death—he was, in fact, wounded while swimming—saved it and set it again; and it was the Serapis which finally struck. The Cumberland went down in Hampton Roads with colors flying; and when recently the old Kearsarge, which sent the Alabama to the bottom, struck on Roncador Reef, in the Caribbean Sea, and her crew was obliged to take to the boats, the ensign was left fluttering in the breeze.

Next to our own flag, that of Great Britain interests us most. It is called the "union" flag because it is three flags in one. The flag of England is a red cross on a white field; that of Scotland, a white St. Andrew's cross on a blue field. These flags were combined when England and Scotland united in 1683; and on the union with Ireland, the Irish flag, a red St. Andrew's cross on a white field, was added. The union of the three countries is thus indicated on the "union." The St. George's cross of England remains as before, and is the central feature of the flag, dividing it into four quarters occupied by the St. Andrew's crosses, the white of Scotland and the red of Ireland, which are placed side by side.

Aboard a British war ship the "union" is hoisted only when the Queen or an admiral is aboard. English ships sail under the British ensign, of which there are three kinds—white, blue and red, each with the union in a square in the upper part of the hoist—that portion of the flag along the staff. The navy, and by special permission, the Royal Yacht Club, sail under the white ensign, which has, besides the union, the red cross of St. George over the whole. The blue ensign is a privilege allowed to those merchant ships which are officered by members of the naval reserve, and one-third of whose crews belong to the reserve. It is also flown by a few yacht clubs. The red is the merchantmen's ensign. Until 1864 the British naval fleet was divided into three squadrons, each in command of an admiral, who was known, by the color of his flag, as the "admiral of the blue," the "admiral of the red," and the "admiral of the white." This distinction was abolished, because it was found puzzling in action, and was often eliminated. Trafalgar, for instance, was fought under the white ensign. The French and Spanish ships went into action without setting their colors, but were later obliged to hoist them, so as to be able to strike them.

In 1797 a fleet of British Indiamen escaped from a squadron of French war ships by a clever ruse. The captain of one of the Indiamen hoisted Admiral Rainier's colors, and the French admiral (Sarcey), thinking he was in danger of attack from a far superior force of British war ships, put about, and, crowding on all sail, made his escape from the harmless merchant fleet. When Lord Cochrane, with the little brig Speedy, attacked the big Spanish Gamo of thirty guns and three hundred men, the Speedy having but fourteen four-pounders and fifty-four men, the Englishman knew his only chance of success lay in boarding the Spaniard. During the melee on the Gamo's deck, Cochrane ordered one of his men to haul down the Spanish flag, and the Spaniards, seeing their colors come down, thought their commander had surrendered and gave up the fight.

The royal standard of Great Britain is personal to the sovereign, and is used only by the sovereign or for decoration on royal fete days. It is quartered, the first and fourth quarters being red, with three lions, and representing England; the second quarter yellow, with a red lion, for Scotland; and the third quarter blue, with a harp, for Ireland.

The history of the American flag is too familiar to need repetition. The stars in number equal to that of the States—a star being added whenever a Territory is admitted to Statehood—form the union, the thirteen stripes representing the original States. Both national and regimental colors are used in the United States army by each regiment (except cavalry, which has only a regimental standard), and by the engineer battalion—the national colors in various sizes. The garrison flag, the largest, is used only at important posts. It is twenty feet on the hoist, with a fly of thirty-six feet, the union being one-third the length of the fly, and in depth to the lower edge of the fourth red stripe. The ordinary post flag is smaller and the storm flag smaller still. The regimental colors of the United States infantry are of blue silk, and bear in the center the arms of the United States. Below the eagle is a red scroll, with the number and name of the regiment in white. The United States artillery has scarlet regimental colors, with two cannon crossed in the center, with "U. S." in yellow above and the regimental number below. The cavalry regimental standard is a beautiful seamless yellow silk, with a four-foot fly and three feet on the lance. The arms of the United States are in blue in the center, and beneath the eagle a red scroll bears the name and number of the regiment in yellow. The United States engineers carry scarlet colors, bearing in the center a castle with "U. S." above and "Engineers" below, castle and lettering being in silver. Battles in which the regiments distinguished themselves were formerly listed on the colors and standards, but are now shown on the staffs. The national and regimental colors and standards are kept at the commanding officer's quarters, and are escorted to the color company or troop amid much ceremony, the escort being headed by the band. The color guard are selected for their soldierly appearance and qualities—men who would rather die than surrender.

The flags of the United States navy are made of American bunting thoroughly tested for strength and soaked in salt water and dried in the sun for colors. There may be some hundred and sixty flags on a United States war ship—say twenty-five foreign flags (according to the station on which she will cruise), twenty American ensigns, eleven pennants, four union jacks, twelve rear admiral's flags (if a flag ship), twenty international signals, and the remainder signal and miscellaneous flags. Ensigns (stars and stripes, of course) run in eight sizes, from that used on vessels with very long spars, such as the new Brooklyn and Minneapolis will have, and which is nineteen feet on the hoist and thirty-six feet on the fly, to the little 2·37 × 4·50 foot boat flag, too small to sport more than the original thirteen States in its union. The No. 1 union jack is the 10·20 × 14·40 foot union of the No. 1 ensign, and the other jacks conform similarly to the unions of the corresponding ensigns. When a captain puts his ship into commission, he hoists, in addition to the ensign, a pennant. This has a fly of seventy feet, the union occupying 17·50, with thirteen stars. The admiral's and vice-admiral's flags of the United States navy, when these ranks are filled, are blue, with four and three white stars respectively. It will be remembered from the Columbian naval review, when our fleet was divided into three squadrons, each in command of a rear-admiral, that we preserve the old English distinction of the blue, the red and the white flag. The Secretary of the Navy flies a blue flag with four white stars, an anchor and cable, the assistant secretary reversing the colors. The President's flag is blue, with the arms of the United States, the eagle and stars white, the shield preserving the "tinctures."

The red and white crossed flag of Denmark is the oldest existing national color, having been in use since 1219.—*The Outlook.*

## THE MAKING OF DIAMONDS.

By VAUGHAN CORNISH, M.Sc., F.C.S.

THE reproduction of the diamond by M. Moissan has put the coping stone to the work of mineralogical synthesis. For some years past it has been thought that the solution of this problem was merely a matter of time and patience; but it is no little satisfaction to be able to say at last that the thing has been done, for it is indeed a striking illustration of the power over stubborn matter which is won by the patient student of science. In the light of what has now been accomplished, it may not be without interest to refer to what was written in this journal on the subject of the production of diamonds previously to the work of M. Moissan. In *Knowledge* for May, 1891, at the conclusion of an article on "The Artificial Production of Rubies," the matter was referred to as follows:

"The great problem in the artificial production of gems is the preparation of the diamond. . . . In the case of other minerals the successful production has generally only been achieved after a minute study of the mode of natural occurrence, and this has afforded guidance as to the best means of imitating the natural process of formation. It is only of recent years that the diamond has been found in its original matrix, so that materials have been wanting on which to base experimental methods. The chemical nature of the body, a combustible substance, is so different from that of the ruby and most other gems, which are oxides or oxidized materials, that the methods to be employed for its production will probably involve the application of different principles. There is no reason, however, to regard the problem as insoluble. When sufficient guiding data have been obtained, skill will not be wanting to imitate in the laboratory the conditions under which nature has worked in the formation of this most beautiful product of the mineral world."

What some of these determining conditions might be was indicated in a subsequent paper on "The Diamond Mines of South Africa," which appeared in *Knowledge* for October, 1891. "To the mineralogist the chief interest of the South African mines lies in the fact that the 'blue rock' or kimberlite appears to be the original matrix of the diamond. . . . It is worthy of note that a black shale forms one of the surrounding rocks and pieces of this shale have been found baked and otherwise altered in the blue rock. The suggestion has been thrown out that the diamonds were formed by the alteration of the carbonaceous matter of the shale *under the influence of a moderately high temperature and great pressure.* Such indications are useful as affording suggestions to the experimentalist, to whom, in spite of previous failures, we must look to tell us definitely how the diamond is formed."

If the diamond be highly heated in the presence of oxygen it takes fire, as is well known, and burns with the formation of carbonic acid. If it be heated not in contact with oxygen it swells up and blackens, reverting to the ordinary charred form of carbon. But the action of heat upon bodies is in many cases very different when they are subjected to high pressure, a principle established by Sir James Hall more than one hundred years ago in his celebrated research on the conversion of chalk into marble, one of the achievements of experimental geology, described in *Knowledge* for July, 1891.

As will be seen, M. Moissan invoked the aid of pressure to modify the action of heat in his experiments and produced diamonds from charcoal, a substance of the same nature as the "shale" which occurs in the Kimberley rock. The formation of crystals is, as a rule, best brought about either by sublimation or by cooling a solution. Carbon, however, cannot be distilled or sublimed, and is insoluble in all ordinary solvents, such as water or aqueous solutions of acids and alkalies, or in liquids such as alcohol, ether or benzene. On the other hand, molten metals can take up or dissolve carbon to a not inconsiderable extent, as happens, for instance, in the well-known process of iron smelting. The molten iron in the blast furnace dissolves some of the carbonaceous fuel, a part of which, when the iron is allowed to cool and solidify, crystallizes out in plates of graphite.

This is an example of the production of a crystalline form of carbon from a non-crystalline variety, and it is, at the same time, an instance of the artificial formation of a mineral.

M. Moissan, in his experiments, employed iron as a solvent for carbon, which was in the form of charcoal; but he modified the action of heat and the solvent by subjecting the carbon-saturated iron to considerable pressure. It may be noted here that M. Moissan finds the principal constituent in the ash of the native diamond to be oxide of iron. It is known also that native diamonds often contain liquefied gases in cavities of the crystal, and that they are sometimes liable to spontaneous disruption, owing to a state of strain which is probably due to their having been formed under high pressure.

In an earlier series of experments, iron melted by means of an electric furnace, and raised to a white heat, was allowed to saturate itself with carbon in the form of strongly compressed sugar charcoal. The crucible in which the operation was conducted was then plunged into cold water, which cools the outer portion of metal so as to form an outer layer of solid iron. While this outer coating is still red-hot the crucible is withdrawn from the water, and the cooling proceeds more slowly. To realize what goes on within the jacket of solid iron, we must remember that the still liquid interior is molten iron, containing a large excess of dissolved carbon, and that iron expands in the process of solidifying. Hence, during the process of solidification within the jacket or crust of chilled metal, great pressure is exerted. The process of solidification, therefore, goes on slowly and under great pressure, and examination of the resulting product showed that, under these changed conditions, a part only of the surplus carbon had crystallized out as graphite, and that in the residue left after dissolving away all the iron by means of boiling hydrochloric acid and other solvents there was a certain quantity of a denser form of carbon (having a specific gravity of 3 to 3·5), and hard enough to scratch a ruby; and that among these heavier portions of the residue were transparent particles, having a greasy or waxy luster and marked with parallel striæ and triangular depressions.

These transparent particles burned when heated to 1,050° C. in oxygen gas and, as it appeared, with the formation of carbonic acid; but the particles were too small to allow of a quantitative experiment. Similar results were obtained by the slightly modified method of rapidly cooling an ingot of molten iron saturated with carbon from a temperature of 2,000° C. In a few cases small fragments were obtained, "qu'ils ressemblent aux petites fragments de diamant transparents que nous avons rencontres dans la 'terre bleu' du Cap" (*Comptes Rendus*, February 6, 1894). The result may be summed up by saying that, up to the date of the experiments described in the above quoted paper, M. Moissan appears to have succeeded in reproducing that transparent variety of carbon of which native diamonds are composed. The specimens could hardly be called diamonds, although they showed certain characters of the native diamond—*e. g.*, a waxy luster, and parallel striæ and triangular depressions on the surface.

Since the experiments above described, a happy modification of the method employed has given results of a far superior kind, perfect diamonds being formed, having the distinctive physical peculiarities of the native stone and of sufficient size for M. Moissan to prove by quantitative chemical experiments upon some of the specimens that they burned with the formation of pure carbonic acid. In the course of experiments made in former years by other experimenters using other methods, transparent crystalline bodies were obtained which were thought to be diamonds, until their failure to satisfy the carbonic acid test showed that the crystalline particles were not composed of carbon.

Moissan's modified method is as follows: Iron is saturated with carbon at the white heat of an electric furnace and under pressure. The crucible containing the molten iron is then quickly lowered to the bottom of a bath of melted lead.

This insures quicker cooling than when the iron is plunged in water, owing to the fact, first, that the white-hot iron does not really come into contact with the water; and secondly, that the lead is a good conductor and carries away the heat rapidly. It seems that the two liquid metals behave toward one another much as oil and water, and the molten iron collects in spherical globules which rise to the surface of the molten lead, the difference in the specific gravity of molten iron and of molten lead being, of course, very considerable. The surface of the drops of liquid iron which float upon the surface of the lead quickly solidifies, the smaller drops with a diameter of one to two centimeters first, the larger drops after a lapse of a longer time, and the solid little balls of iron are left to float on the molten lead, where they cool down. The interior of the balls is of course liquid long after the formation of the solid crust.

The tendency of the central parts to solidify is resisted by the solid crust, owing to the fact before mentioned, that iron expands in the act of solidification. Meanwhile a part of the carbon crystallizes out from its solution in the liquid iron. After a time, as the cooling goes on, the lead also solidifies, and the little iron balls are left embedded in the ingot of lead. Then begins the process of getting at the small quantity of the carbonaceous material which it is desired to examine. The lead which adheres to the iron is dissolved away with nitric acid; the iron itself is dissolved by hydrochloric acid, and further treatment with suitable solvents leaves the sought-for residue, a small quan-

tity of material left after the tedious process of removing by slow chemical means the relatively large mass of metal.

Transparent diamonds are found in the residue having well-defined crystalline faces, striated and marked in the well known way, and the edges generally curved; they have the high refracting power, the specific gravity and the hardness of the native stone. The peculiar form known as the hemihedral predominates among these crystals as in those of native diamonds, and their formation under pressure is found to give rise to the phenomena of anomalous polarization of the light which passes through them, as well as occasionally to spontaneous disruption; characters which, as has been mentioned, are sometimes noticed in the native stone. The diamonds are of course small; one with a diameter of half a millimeter appears to be reckoned a fine specimen.

Further practice in working the process will probably enable larger specimens to be obtained, as has been the case with the production of rubies, which are now produced of a size sufficient to be used in the jeweling of watches.

However this may be, the production of diamond is now an acknowledged fact, achieved by the patient skill of the same worker who, seven years ago, successfully overcame the great experimental difficulties which had rendered fruitless the many former attempts to isolate the chemical element fluorine.—*Knowledge.*

## CRUDE CARBOLIC ACID.

By H. W. JAYNE, Ph.D.

THE composition and methods of preparation of the crude carbolic acids of commerce appear to be so little understood by pharmacists generally that it seems as if a few remarks about them, from one who has practical knowledge of their manufacture, might be of interest to those present.

Many text books state that crude carbolic acid is prepared by repeatedly distilling a portion of the coal tar, until a fraction is obtained boiling between 170–190° C., which is then extracted with a strong solution of caustic soda. This method is not used at present in large works either here or abroad.

While it is possible to obtain a fraction rich in acids by repeated distillation, yet the total yield is less, for a certain amount is lost in each distillation, either by volatilization, or being destroyed by contact with the heated sides of the still.

In this country, as a rule, the tar is distilled in two fractions. The first, consisting of all the lighter portions, is called the light oil, and is collected until a sample of the oil that runs from the still sinks in water. The whole fraction when mixed has a gravity of from 0·94 to 0·99. The second fraction, consisting of about 20 per cent. of the tar, constitutes the creosote—or heavy oil—commonly called dead oil. The residue left in the still is soft pitch. In some cases the first portions of the dead oil are collected separately, in order to obtain a fraction as rich in acids as possible, which is then known as carbolic oil. The light oil, which boils between 90° and 250° C., contains from 4 to 10 per cent. of acids, and therefore nearly all of the carbolic acid, or true phenol, boiling at 182°.

The dead oil contains from 10 to 20 per cent. of acid, the carbolic oil, if made, sometimes shows as high as 30 per cent. The oils contain also a certain amount of carbolic acid, but the proportion is much less than in the light oil.

In Europe, where most of the crystal carbolic acid is made, the fractions are collected differently. The first portion running from the still, containing most of the benzol and toluol, is called crude naphtha or first runnings. The second portion, which is collected as long as the distillate is lighter than water, is called light oil or second runnings, and is very rich in phenol. The third fraction constitutes the carbolic oil. The portion to be extracted is agitated with a weak solution of caustic soda, about 10 per cent. is the right strength. If a strong solution is used, many impurities contained in the oils, especially naphthaline, are also dissolved and contaminate the finished acid. After agitation the mixture on standing separates into two layers—the upper consisting of the extracted oil, the lower the solution of carbolate of soda. This latter is drawn off, and on acidifying with either sulphuric or hydrochloric acid, the tar acids are liberated, and float on the surface as an oily layer, holding more or less water in solution, depending on the nature of the acid present. For convenience in consideration, we will arbitrarily divide the crude acids into two classes.

(1) Crude acids for the manufacture of crystal carbolic acid.

(2) Crude acids for disinfecting purposes.

Acids of the first class are not a regular commercial article in the United States, as there is only one firm manufacturing crystal carbolic acid, but in Europe, especially in England, they are prepared on a very large scale. As their value depends on the amount of crystal acid they contain, they are sold by test. Crystal carbolic acid being the first of the series of phenols, has the lowest boiling point. Therefore, the boiling point of a crude acid is to a great extent an indication of its value.

In England, an arbitrary method has been devised by Lowe, which gives an approximate idea of the value of these acids. A sample (say 100 c. c.) is distilled in a retort or flask. At first water passes over, then an oily liquid.

When 10 c. c. of this latter have been collected, the receiver is changed, and the next 62½ c. c. collected apart. The residue in the retort is cresylic and higher acids. The 62½ c. c. obtained as a second fraction is cooled, and the solidifying point ascertained by a thermometer placed in the liquid. These crude carbolic acids are sold as 50°, 60° or 70° acids, meaning thereby that the second fraction of 62½ c. c. crystallizes at 50°, 60° or 70° F. That containing the most crystal acid showing the highest melting point.

A good quality of 60° English crude carbolic acid distilled as follows:

| | Per cent. | |
|---|---|---|
| To 180, | 17 | (11 p. c. water) |
| " 185, | 21 | |
| " 190, | 71 | |
| " 195, | 88 | |
| " 200, | 93 | |
| " 205, | 95 | |

The portion representing the 62½ c. c. distilling between 184¾° and 193°.

A very good grade of light oil must be used to obtain such an acid; if a higher fraction of the tar is extracted, the acid obtained shows a correspondingly higher boiling point.

The following acid was extracted from the first portions of the dead oil:

| | Per cent. | |
|---|---|---|
| To 180, | 14 | (11 p. c. water) |
| " 190, | 20 | |
| " 195, | 55 | |
| " 200, | 74 | |
| " 205, | 82 | |
| " 210, | 88 | |
| " 220, | 91 | |
| " 230, | 93 | |

The 62½ c. c. of this acid did not crystallize until cooled to 25° F. If insufficient soda is used, it would be possible to extract, even from an oil of this nature, a certain amount of acid rich in phenol. Phenol has a greater affinity for soda than its homologues; therefore, if one-half the soda necessary for complete extraction is used, the solution will contain a greater proportion of phenol than if the material were extracted completely.

This is clearly shown by the following experiment.

A sample of oil was treated with three equal portions of weak caustic soda solution, the last portion extracting the oil completely.

Each solution was neutralized with sulphuric acid, and the resulting acids distilled. In order to show their composition more clearly the result is calculated after deducting the water present.

Acid from:

| | First Portion. Per cent. | Second Portion. Per cent. | Third Portion. Per cent. |
|---|---|---|---|
| To 180, | 6 | — | — |
| " 185, | 30 | — | — |
| " 190, | 74 | 1 | — |
| " 195, | 86 | 41 | 2 |
| " 200, | 91 | 71 | 16 |
| " 205, | 94 | 83 | 54 |
| " 210, | — | 87 | 74 |
| " 215, | — | 91 | 84 |
| " 220, | — | — | 88 |
| " 225, | — | — | 92 |

The first portion is equal to a 60° acid, and contains a large amount of phenol; the third portion, none at all. To prepare crystal acid from these crude materials, they are carefully rectified in large iron stills, the watery portions separated, and the fractions from (say) 180° to 190° cooled, the phenol crystallizes and is drained from the liquid portions. The crude crystals thus obtained are then carefully refined. As the crystal carbolic acid has a much higher value than the other acids, it is in the interest of the manufacturer to remove it as completely as possible. The remaining liquid acids are sold as "crude carbolic acid 100 per cent." as they are entirely soluble in caustic soda solution, excepting traces of naphthaline and other impurities.

The lowest grades of crude acids, known as 10, 15, 20 and 25 per cent., are simply unextracted portions of the heavy oil, containing this amount of tar acids. The higher grades, 50, 60 and 70 per cent, are prepared by adding 100 per cent. to the lower grades.

As the heavy oils used in mixing these acids contain a large number of bodies, these are of course present in the commercial acids. The most important of these are the pyridine bases and naphthaline. The former gives to certain acids a rank, disagreeable smell. The latter is generally present in large amounts, some oils consisting of more than half crude naphthaline. In cold weather this naphthaline is deposited, and as the liquid portions are drawn off, it finally remains in the barrels as an oily mass, which will not again become liquid, thereby occasioning a serious loss to the purchasers. It does not appear to be generally understood that these acids consist largely of oil, for it is a common occurrence to find disinfecting acids in bottles, labeled with directions for mixing with water, when a test shows that it is entirely insoluble in water, and contains only a small percentage of acid.

Many methods of testing crude carbolic acids have been proposed, which apparently ignore the large per cent. of oil present.

An instance of this is the method recently proposed by Seiler, and which has been extensively copied by journals throughout the country.

His method is to weigh 100 grammes of the sample in a large beaker, adding milk of lime (obtained by slaking 200 grammes of lime) and diluting to one liter. The whole is placed on a water bath and stirred for an hour, after which the same amount of water is again added, when cold it is filtered, washed with fresh water and filtered again. The acid is liberated by hydrochloric acid, salt being added to the solution to remove as far as possible the acid dissolved in the liquor. It is then separated and weighed. He sums up the result of his investigation by stating that an acid sold as 25–30 per cent. showed only 2 to 3 per cent.; a 40–60 per cent. acid gave 3 to 5 per cent.; a 50–80 per cent. and a 90–100 per cent., 80 per cent. From this he concludes that commercial acids contain considerably less than stated, and that the lower grades are worthless.

To one acquainted with the nature of crude carbolic acids, the defects of this method are at once apparent. The slaked lime on mixing with the acid forms an oily mass, from which it is nearly impossible to extract any acid. Lime is too weak a base to extract the last portions of acid from the oil, and the voluminous liquid, amounting with the wash waters to about three liters, dissolves a large percentage of the acid even when saturated with salt.

It will be noted that the crude acid said to contain the larger amounts gave better figures than the low grades, which was to be expected, as there was about the same amount dissolved in the salt solution from that acid that should have given 25 c. c. of acids as from that which should give 100 c. c.

As these crude acids are only for disinfecting purposes, and as cresylic and the higher acids are now recognized to have the same, if not better, disinfecting properties than phenol, it does not seem necessary to determine any other point than the total per cent. of acid they contain. No simpler method can be devised than the well known one of shaking a certain quantity of the material in a graduated vessel, with weak caustic soda, and noting the decrease in volume. To verify the result the soda solution can be acidified and the tar acids measured. The amount liberated is always less than that indicated by the decrease of the volume of oil, owing to the solubility of the acid in the salt solution.

For this test I would recommend a 100 c. c. burette, divided in tenths, and furnished with a glass stop cock. It is filled to the 50 c. c. mark with 10 per cent. of caustic soda solution; 25 or 50 c. c. of the acid to be tested is then added, the burette closed with a cork and well shaken. On allowing to stand, the decrease in the volume of oil is readily measured; 50 c. c. soda of the strength indicated is sufficient to saturate 12 c. c. of 100 per cent. acid. If it is necessary to add more soda, the already saturated solution can be readily drawn from the burette and another 50 c. c. added.

Frequently the percentage of naphthaline in low grade acids is so great that it separates from the liquid as soon as the acids are removed; as this prevents an accurate reading, it is necessary to add 10 to 15 c. c. of benzol to dissolve the deposit.

In some cases the acids are contaminated with tarry or resinous bodies, which dissolve in the caustic soda, rendering the solution so dark that it is impossible to see the line separating the two liquids. In this case it is advisable to distill another 25 c. c. portion nearly to dryness in a small flask, considering the distillate as 25 c. c., and repeating the test. The entire operation requires but a few minutes, and the results of many hundred trials show it to be accurate enough for general purposes.

A mixture of equal parts of heavy oil and cresylic acid was made, and tested by the above method. The contraction showed 49½ per cent. of acid present, the liberated phenols gave 49 per cent. The same mixture tested by Seiler's lime method gave only 22 per cent., every precaution being taken to insure a good result.

Another mixture prepared with 25 per cent. of acid gave 24½ per cent. by extraction, and 24 per cent. of phenols set free. The lime method gave but 6 per cent.

The Pharmacopœia requires that 50 volumes of a crude acid mixed with 950 parts of water should not leave undissolved more than 5 volumes or 10 per cent. It is difficult to understand for what reason such an arbitrary test is required. Fifty c. c. of insoluble residue in 1,000 c. c. of solution is difficult to measure with accuracy, particularly as the acid often adheres in fine globules to the sides of the measure. This may seem a small objection, yet it is very important when the acceptance or rejection of a large lot of acid depends on it.

A sample of excellent 60° crude carbolic acid was tested by the method of the Pharmacopœia, and answered its requirements, about four volumes remaining undissolved. Another portion of the same acid was then distilled to remove the small amount of tarry matter and about 11 per cent. of water present. This fine light colored acid showed by the Pharmacopœia test fifteen volumes or 30 per cent. insoluble. In other words, an acid containing all the best portions of the first sample and having 15 per cent. more value as a disinfectant, would not stand the test.

A sample of distilled cresylic acid, free from water, distilling to

| | Per cent. |
|---|---|
| 190 | 12 |
| 195 | 70 |
| 200 | 88 |
| 205 | 97 |

gave 25 volumes or 50 per cent. insoluble. It was found necessary to add 75 per cent. of crystal carbolic acid (melting point, 35°) to 25 per cent. of the above cresylic acid, before a mixture could be obtained which would give a satisfactory result.

As the Pharmacopœia requires an acid for disinfecting purposes only, and not for preparing crystal acid, it is useless to require such a high per cent. of phenol, and it would be undoubtedly to the purchaser's interest to buy an acid free from water. If the idea is to prevent the use of the higher boiling phenols, which are very little soluble in water, the difficulty could be overcome by the following requirements:

It should not be soluble in less than 15 parts water at 15° C., and the aqueous solution should not have an alkaline reaction. It should dissolve in 10 per cent. caustic soda solution, leaving not over 5 per cent. insoluble. Should not show over 2 per cent. water, and 90 per cent. should distill under 225° C.—*Am. Jour. Pharm.*

## CHLORIDES OF SODIUM AND POTASSIUM.

By T. PARKER and A. E. ROBINSON, of Wolverhampton.

IN the electrolysis of chloride of sodium and chloride of potassium caustic soda and caustic potash are formed, respectively, at the negative pole, and chlorine gas is liberated at the positive pole; but the full electro-chemical efficiency of the reaction has not heretofore been obtainable, owing to the tendency of the two ions to recombine. The object of this invention is to provide means to be employed in connection with the said electrolysis, whereby or through the medium of which the electro-chemical efficiency is increased and useful products obtained. This is effected by removing the caustic alkali from the sphere of electrolytic action by combining it with oleic, stearic, margaric or other organic fatty acid, which in consequence of the lower specific gravity of the compound which is thereby formed, and its insolubility in the electrolyte, rises to the surface in the cathode compartment, and can be removed therefrom as may be convenient. The acids may be added as oils or fats, such as tallow, olive oil, cottonseed oil, palm oil or the like, in which the fatty acid is combined with glycerine, or the acids may be used after they have been separated from the glycerine. Or the electrolysis of the solution may be continued so long as an amount of caustic soda (or caustic potash) is formed practically corresponding with the theoretical amount obtainable for the amount of electrolytic action expended, then the solution removed and the caustic soda or potash contained therein converted into the insoluble compound before mentioned, after which the electrolysis of the chloride so-

lution is proceeded with as before. The soap compound made as above described may be used as soap or for any purpose for which it is suitable, or the compound may be treated with carbonic acid gas and the fatty acid thus recovered from it, while the alkali is converted into a carbonate.

## FAVE'S DIVING TIDE GAUGE.

IT is now nearly three years ago that Mr. L. Fave presented to the French Society of Physics the interesting apparatus that we propose to describe. The reason that we have not done so sooner is that we have been waiting for it to assume its definite form as a result of the experiments to which it was to be submitted. It has, in fact, been sensibly improved during these three years without the principles upon which it is based having been in any way modified.

The tide gauges permanently installed in a few ports of the coast are excellent, faithful and easily maneuvered instruments, but it is not always possible to make use of them. They necessitate, in fact, a structure whose lower part shall be always washed by the rising tide, and do not lend themselves to a flying installation, upon a strand or even upon a cliff. The scales that may be fixed at a short distance from the coast are liable to be destroyed by the tide or by the malevolence of the shore dwellers, even in civilized countries, and, moreover, as an observation of them, at sufficiently approximate intervals, is very necessary, it would be advantageous to substitute the use of a registering apparatus therefor. Finally, none of the tide gauges known permits of observations in an offing, at somewhat considerable depths. It will be seen, nevertheless, how great an interest attaches to such observations, since the coast has a very great influence upon the tide.

It is to such multiple *desiderata* that the Fave instrument responds. This gauge does not, like those with which we are familiar, register the height of the water, but the pressure, or, more exactly, the variations of such pressure, through a very ingenious mechanism. Upon the whole, it is nothing more than a sea bottom barometer.

In its definitive form (Fig. 1) it consists of two Bourdon tubes fastened to blocks that remain fixed in a same series of observations, but the position of which can be regulated through adjusting screws. Their movable extremity carries flexible strips, L, each of which is provided with a very fine point, P. The pressure of the water, transmitted by the tube, C, opens the spirals and separates the points, one of which moves forward and the other backward. It is the motion of these points that is inscribed. To this effect, a disk of glass, V, covered with varnish and carried by the pillar plate of a clockwork movement, revolves in front of the points, which leave a trace of their passage in the varnish. The very judicious use of two points instead of one point renders the result independent of the centering of the glass disk. It suffices, in fact, to measure the variations in the spacing of the two lines in order to completely eliminate the imperfections of the apparatus. The two small handles that carry the letters, A and B, serve to press the points against the disk or to separate them from it by means of inclined planes that engage under the flexible pieces, L and L. The entire apparatus is contained in a box, and the interior of the spirals alone communicates with the surrounding medium.

The inscription of the very feeble motion of the points presents peculiar difficulties. The lines must be extremely fine if it is desired to obtain precise results. Silvering gives satisfaction in this respect, but it rapidly blackens, and the lines soon become invisible. Lamp black is difficult to use, and aniline colors are too hygroscopic and the least condensation of moisture clogs up the lines. Nitrate of rosaniline, which is but slightly soluble in water, lends itself to tracings whose fineness is limited only by that of the points. A saturated solution of it is made in concentrated alcohol, say 2·2 grammes to 100 cubic centimeters of alcohol and 10 cubic centimeters of ether. The solution is spread over the disk, which is turned up vertically and exposed to heat until dry. The thickness is varied by modifying the proportion of ether.

Such as we have just described it, the apparatus is perfectly adapted for depths of about ten meters, but when it is desired to submerge it to greater depths, there are two difficulties encountered; if the spirals are thin, they become too much distorted, and if they are too thick, they no longer visibly inscribe the variations of level.

Mr. Fave has solved the problem by causing only a part to act, and, so to speak, only the variations of the pressure of the apparatus. The artifice employed by him is identical in principle with that upon which is based the Richard statoscope, but it is applied in a very different manner.

For experiments at depths of more than ten meters, the apparatus is inclosed in a metallic cylinder (Fig. 2, No. 2) provided with an aperture at the lower part. It is put in communication with a rubber bag filled with air, through the intermedium of a tube passing under a clamp external to the apparatus (Fig. 2, No. 1). This clamp consists simply of a piece of wood pressed upward by a spring. A coun erpoise keeps the clamp open. The water, gradually entering the cylinder, compresses the bag, and the air, forced into the box of the apparatus, balances the pressure in the interior of the spirals at every instant. When the vicinity of the bottom is reached, the weight deposits, the rubber is compressed and the pressure in the box remains con-

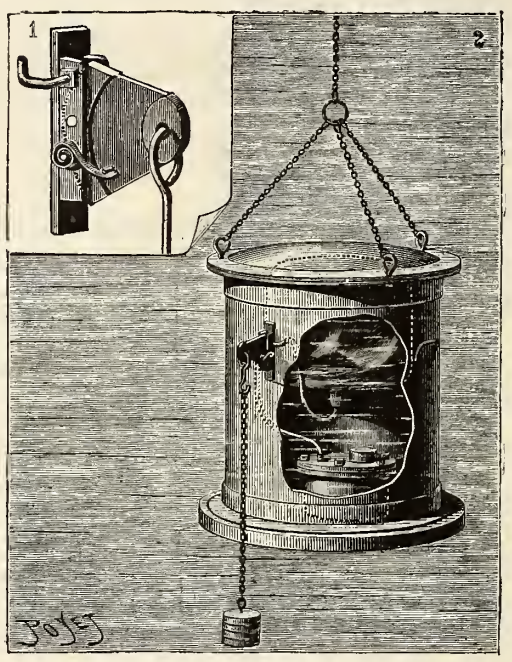



FIG. 2.—FAVE'S TIDE GAUGE.

1, clamp; 2, apparatus inclosed in a metallic cylinder.

stant from this moment. The apparatus is thus in the same conditions of sensitiveness as if it had above it a column of water equal to the length of the chain that supports the weight. The rubber forms at the point where the clamp is situated a curve into which a drop of glycerine is introduced in order to assure a perfect closing.

The apparatus is so constructed that the disk makes one revolution in two days, but it is useful to inscribe the tides at the same place for eight days at least. The use of the two movable points permits of superposing several periods upon the same disk, for the lines always intersect each other at an angle sufficiently wide to allow them to be followed without ambiguity.

We shall finish by citing one of the results obtained with the apparatus. At 200 kilometers, at least, from Brest, and at a depth of 150 meters, it was found that the tide had an amplitude about half less than at the coast. The result cannot be given in precise figures, since, in this experiment, the operation of the apparatus was perturbed by a leakage. But the measurements are going to be taken again, and will doubtless enlighten us as to the delicate question of the action of the coasts upon the tide.—*La Nature.*

## CONTAGION AND PHTHISIS PULMONALIS.

By Sir BENJAMIN WARD RICHARDSON, M.D., F.R.S.

AS if to discount good influences of a true hygienic character in reducing the death rate from phthisis pulmonalis, some enthusiasts, in writing on the contagion speculation, have endeavored to show that the lessened mortality from the disease, observable during the past few years, is due to the influence of the doctrine of contagion. Dr. Lawrence Flick, of Philadelphia, has written in this strain in the *Medical News* for May 14, 1892. He calculates that the actual decrease of deaths from phthisis in Philadelphia, from 1881 to 1891, is 0·734 per thousand of living people, which, with the present population, shows a saving of 784 lives a year. The result he assumes to be due to the circumstance that members of the medical profession in Philadelphia, having become converted to the hypothesis that phthisis pulmonalis is spread by contagion from particles of dried sputum derived from patients affected with the disease, have taken care that such contagious matter shall be at once destroyed, and so have prevented the spread of the disease by communication. It is astounding how speculations of the kind named are supported on coincidences. There is a physician living in this country who, with equal argument, believes that the reduced mortality from the disease in question is due to a medicinal cure for the disease which he himself has introduced. To prove the beliefs of such advocates, it would have to be demonstrated how many practitioners have prescribed the means of prevention or cure specified, and how many times their suggestions have been practically acted upon. Impossible demonstrations! As to the first—the conversion of the profession to the hypothesis of contagion and the influence of that conversion in modifying the death rate—it is the simplest truth to say that if the profession in Philadelphia is at at all like the profession here, there is not a shadow of evidence in support of the proposition. There are a few probably who, accepting the hypothesis out and out, are more particular respecting cleanliness and removal of expectoration than they were; while the many, looking at the hypothesis doubtfully, are as little influenced by it now as they ever were. Why should this not be so? The experience gathered in Naples on this subject, when the most rigid rules for destruction of all morbid material failed to render service, is not likely to be forgotten; while the majority of observers have never been able to see the evidence that would establish the hypothesis. Let me take in illustration my own experience. In my student life I was under an able teacher of the practice of medicine, the late Dr. Andrew Anderson, of Glasgow. In his lectures on phthisis, he entered carefully into the contagion theory, at that date—1846—rather popular. He held a wise reserve on his own part; but he told us the question was a vexed one, and he urged us all to watch most carefully for ourselves in our future lives. I was one who determined to watch intently, without bias—how could I have any occasion for bias?—and persistently. I have sustained my watchfulness in the same spirit from then until this day, *i. e.*, over a period of nearly fifty years. Every opportunity has been afforded me for watching. I entered early in life into the experience of a large general practice; I left that for physician's practice in London. I became physician to an infirmary for diseases of the chest, situated in a densely populated part of London. I held my post for about fourteen years, rising to the senior physicianship. During a part of this same period I acted as one of the physicians to the Metropolitan Dispensary, the Blenheim Street Dispensary, and the Margaret Street Dispensary, another institution for the treatment of consumption. This was a wide field for practice and for observation. Moreover, at these institutions, where I gave systematic instruction, I was fortunate in having able assistants, who kept careful notes of the cases under treatment. In the course of the period named, no fewer than three thousand patients suffering from phthisis came before me; and during all the time the question of evidence on the point of contagion was never for a moment lost sight of. It is the fact that in all this field of practice not a single particle of evidence ever came before me that sustained the contagion theory, or gave, on reliable data, the least color to it. No professional brother, no assistant, no nurse, no person connected in any way with the phthisical sick, ever afforded indication of having received the disease by communication; and it is worthy of remark that no physician of my acquaintance, in the days I speak of, ever expressed a suspicion of communication by contagion. In the fifties, we had in London a society for the special study of chest diseases. In it were men of acute observation, and of skill in diagnosis. We were all engaged in hospital practice, and we all worked earnestly. The late Drs. Baly, Snow, Leared, Sibson, Francis Webb, Risdon Bennett, Edward Smith, were members of this society, as were Sir Richard Quain, Dr. Hawksley, Dr. Cockle, and one or two more whose names escape me. We met in turn at each other's homes; we drafted patients to our meetings for careful study; we discussed every point with the utmost freedom of discussion; but I feel sure at that time not one of us entertained seriously the hypothesis of contagion. Was it that we were all blind to evidence which must have been passing every day before our eyes, evidence which should have occurred to us, apart from any hypothesis, if it existed? Was this revived hypothesis wanted to open our eyes? Or was it that when the hypothesis was once restarted those who accepted it did not really see what they had failed to see previously, but were led to adapt their discernment to the requirement and to receive what was necessary to be received in order that the hypothesis might stand on a logical foundation?

I resigned my work as physician to the special institution for diseases of the chest toward the latter part of 1867, but I have remained up to the present time profiting from another course of experience in a practice of twenty-five years. In the latter part of that time much controversy has been revived on this subject of the communicability of phthisis by contagion, and although I have taken little public part in the controversy, I have been as active in observation as ever I was, endeavoring to learn, without the least prejudice, the exact facts. For many years I have sat at a board of insurance directors, feeling all the responsibility that attaches to that official duty. In every case of phthisis pulmonalis that has come under my notice in practice, and in every case of the same disease of which I have had cognizance otherwise, I have been vigilant to arrive at the circumstances under which the first symptoms of the disease were manifested. Not once has there been evidence of origin of phthisis from contagion on which I could rely. It is true I may more than once have heard the con-

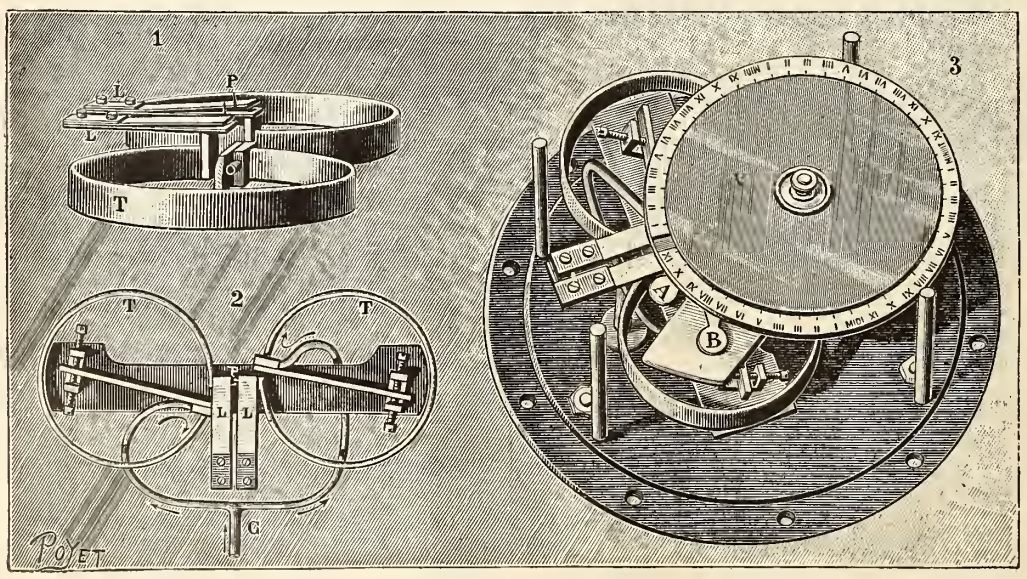



FIG. 1.—FAVE'S TIDE GAUGE.

1 and 2, details; 3, the apparatus as a whole.

clusion that some contagious influence was at work, but on further inquiry the evidence has broken down. There were living near to me two sufferers from the malady who occupied the same house. They were brother and sister, the only children of a professional friend; they had the hereditary history painfully characteristic of phthisis, and in the course of the affection in them from the beginning to the fatal end their symptoms ran so closely as to be like twin phenomena. Could there have been contagion in these cases? Many might have said so who had not taken pains to investigate the facts. To me the facts were familiar. The brother was often assisting me in my work, so that I knew his history; and his attack dated from a severe cold contracted by exposure to an intense chill at an evening party, to which he went lightly clad, and in which he added to the risk from changing portions of his dress for some much lighter ones in order to take part in a charade or play. He sent for me at once when he became ill. It was the old story of pneumonia followed by rapid tubercular phthisis. The sister at this time was many miles in the country, where she had been for several months, during which time the two had not once met each other. She, like her brother, took a severe cold; and when she came home, and passed under my care, she was in the same state of phthisis as he. In neither case was there the remotest evidence of contagion, yet because of their affinity I afterward heard it adduced that contagion was at work. Not infrequently on being called upon to prescribe for phthisical patients the statement has in late times been made to me that the disease had been contracted by contagion, but in not one instance has any proof been supplied that would in a court of law of the first instance bear investigation.

I ask naturally in conclusion, Can I be blind to open facts, or do I see correctly, and has the hypothesis of contagion blinded those who see differently from myself? Willingly I will admit myself blind, and will submit myself to any correction that will give me sight; but the correction must be supplied, and in a form that makes all so clear that he who runs may read. I must be shown one case of phthisis in which the evidence is absolute that the disease was contracted from contagion, and that it could not possibly have been produced by any other determining cause.

Returning to Dr. Flick and his argument—that the mortality from consumption in Philadelphia, or any other city for the matter of that, is reduced by the precautions taken in regard to the disposal of the sputum of afflicted persons—the point is clear enough that what he traces as cause and effect is due to nothing more than coincidence.

No sanitarian for the past forty years, to my knowledge, has doubted the fact that phthisis pulmonalis will disappear just in proportion as broad sanitary views are established and brought into practice. We have all believed, and, as we think, proved, that under new conditions, in which there is provision for a better heredity, in which cleanliness becomes the watchword of sanitation, in which the youth of both sexes can enjoy free exercise and recreation in the open air, and in which the labor of life in confined places is being reduced to a proper standard; we have all believed that with these changes the disease would die out altogether. In my Essay on the Hygienic Treatment of Pulmonary Consumption, published in 1856, these principles were so strenuously enforced that I was looked upon in enforcing them as a visionary, and as wanting in that practical acumen which was necessary for successful effort in the treatment and prevention of disease. I was not alone in that argument, but I was one of a very few. In time our principles prevailed, and the reduction of mortality from consumption in military barracks, owing to reforms which were insisted upon in our teaching, afforded direct evidence, long before this contagious idea was advanced, of the truth and correctness of our observation.

The process of purification has since then gone on by leaps and bounds, and we are beginning to see the good results; a new hypothesis springs up coincidently which may or may not be right to a certain extent within its own narrow range, but which has no more to do with the great results at this time boasted of than the reduction of typhus in its worst forms has to do with carrying of camphor in the pocket, or placing rue in the wardrobe or on the desk before the judge of assize. It may be quite practical, it is quite practical, to take care that the expectorated secretion of consumptive patients is destroyed. The late Dr. William Farr put his finger on this fact, and every sanitarian felt the importance of his advice. But this is merely a matter of cleanliness, merely a part of the whole system of perfect hygiene; and if we let this one thing stand as if it were the whole thing, we shall merely lead to carelessness in regard to everything else, and shall make matters worse instead of better. Dr. Flick is so good an observer and so earnest a man, there can be no hesitation in being critical on this particular part of his instructions, and it is only because it is painful to see him narrowing himself to one issue that this criticism is ventured upon. I hope he will take a wider view as time rolls on, and accepting the old message of the Mishna, that "Outward cleanliness is inward godliness," or, as John Wesley transformed it, "Cleanliness is next to godliness," will become a preacher of true catholic doctrine in all that relates to sanitation and the physical welfare of the world.—*The Asclepiad.*

## AUGUST HIRSCH.

AUGUST HIRSCH, the founder of historical-geographical pathology, died in Berlin January 28, after a long illness. He was born October 4, 1817, in Danzig, and studied in Berlin and Leipzig. His career was influenced particularly by Hecker, the historian of medicine, and Schonlein, the clinic professor. He graduated in Berlin in 1843, his thesis being on the subject of croup, and after having taken the state examination, he began practice. This did not prove entirely satisfactory to him, and he thought of entering the Dutch East Indian Colonial service; he was, in fact, in the Hague, ready to enlist, but was prevented from taking the final step by the advice of a German physician who had had disagreeable experiences in this service. This plan, however, affected his whole future, for he had begun the study of medical geography in order to be prepared for medical service in the Indian Colonies. He first interested himself in malaria, the most common of tropical diseases, and then in the relation of malaria to tuberculosis which was then supposed to exist. Later he occupied himself with diseases of the typhoid type.

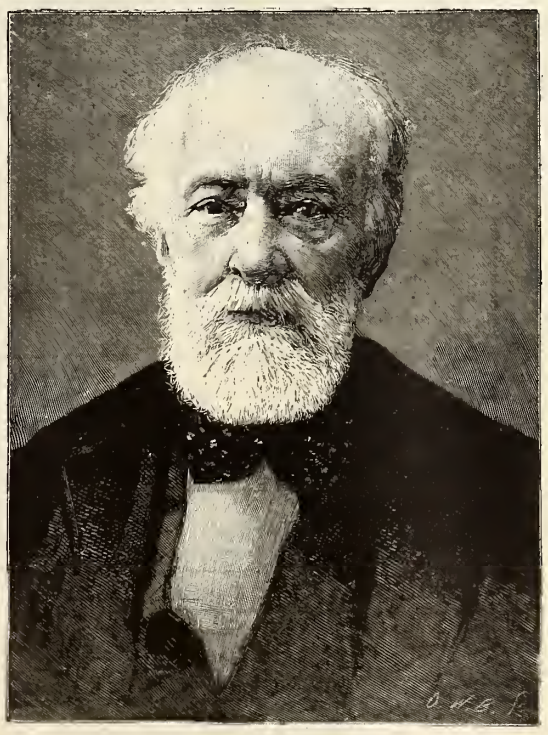
In further pursuance of these studies he entered upon a new undertaking, the study of diseases from a geographical and historical point of view. To be sure there had been some investigations of this nature which would serve as stepping stones to a historical pathology, but Hirsch's work was of a different nature; he showed the organic connection of geographical medicine with researches in the history of medicine. His "Handbuch der Historisch-Geographischen Pathologie" (Handbook of Historico-Geographical Pathology) appeared first in 1860–1863, and again, fully revised,

AUGUST HIRSCH.

in 1880–1884, and caused a great sensation, but the author would have continued to occupy the modest position of a practicing physician in Danzig, if he had not been called to the Berlin medical faculty. Here he found his proper field for work. The faculty immediately began to study hygienics, and Hirsch, whose researches in regard to epidemics were well known, was the adviser of the administration, which sent him to West Prussia to study cerebro-spinal meningitis, to West Prussia and Posen to study cholera and to Astrakhan to study the plague. He also took a prominent part in the cholera convention. It is true that later, after the dawn of the bacteriological era, Hirsch no longer stood in the foreground as adviser. But the change in the state of affairs did not prevent his recognizing the importance of the study of bacteriolgy in connection with hygiene, although he earnestly warned the profession against the error of attributing epidemics exclusively to this cause. Much of his time was occupied in editing the "Jahresberichte uber die Fortschritte der Medecin" (Annual Report of the Progress of Medicine), the "Biographical Lexicon," and the "Allgemeine Deutschen Biographie" (Universal German Biography). He also found time to write "Geschichte der Medicinischen Wissenschaften" (The History of Medical Science), which, with the "Historisch-Geographischen Pathology," will secure Hirsch a lasting fame. For the portrait of August Hirsch we are indebted to our contemporary the *Illustrirte Zeitung.*

## LOUIS KOSSUTH.

THE career of Louis Kossuth closed as it began, amid storm and patriotic excitement. While Kossuth lay on his deathbed, the national party in Hungary were using his name as a firebrand against the government, and his death produced a popular demonstration which has kept Hungary in a fever ever since. The national mourning has been genuine and sincere, for his long exile of forty-five years had not dulled the nation's gratitude. Nearly half Kossuth's life had been spent away from his native country, for he was almost ninety-two years old at his death. He was of Slavonian descent, and was born in 1802 at Monok, in the county of Zemplin, a rich agricultural district, where his father practiced as a lawyer. Young Kossuth was brought up to his father's profession. He first came into notice through his excellent parliamentary reports when sitting in the Presburg National Diet as representative of the absentee landlord Count Hunyady. These reports were published as a *Parliamentary Gazette*, and soon got Kossuth into trouble with the Austrian government when the young writer extended his reports to the Pesth Assembly. He was arrested, tried for high treason, and condemned to four years' imprisonment. Public feeling, however, was too much for the government, and Kossuth was released. Through the medium of his newspaper, the *Pesth Journal*, the first political organ in Hungary, Kossuth steadily worked for national independence with such success that when the revolutionary breeze of 1848 blew throughout Europe, the time was ripe for action. Kossuth, then leader of the Pesth Lower House, proposed the address to the Emperor Ferdinand, demanding Hungarian independence, and when the insurrection in Vienna had cleared the way he entered the capital in triumph to present the demand in person, and meet with a wildly enthusiastic reception. The Emperor granted a separate government for Hungary, and from that time Kossuth devoted his whole energies to developing the civil and military institutions of his beloved country. His work was hardly complete before the Croatians, led by Jellachich, revolted against Hungarian supremacy. By then Kossuth was disgusted with the weak Austrian sovereign, and threw off the lest vestige of allegiance when he called upon the Hungarians to rise in defense of their land. Then followed the struggle in which the Hungarian successes were rendered fruitless by the intervention of Russia. Thoroughly disheartened, Kossuth resigned his powers to Gorgey, and, when the latter surrendered to Russia, Kossuth fled to Turkey, only to be imprisoned and proscribed. Austria demanded his life, but, through English and American influence, the patriot was at last set free to find asylum in that general refuge of the destitute—England. Here he received ample hospitality and for several years remained in London stirring up his compatriots to maintain their lost cause. He was never to return to his country, for when the long desired constitution was given to Hungary and Emperor Francis Joseph was crowned king, Kossuth refused to share in the general amnesty and to be reconciled to the Hapsburg dynasty. For the last thirty years Kossuth lived in Turin, where he passed away on March 20, after a long illness. His death was the signal for a fresh outburst of political animosity. As the Hungarian government refused to accord state honors to Kossuth's remains, although willing to allow him to be buried at Pesth with all due ceremony, violent rioting broke out. The students led the way in disorder, preventing the theatrical performances and hoisting black flags, while the mob took the opportunity to loot and riot wholesale. Eventually the military quelled the disturbance, and Kossuth's sons telegraphed that they would not permit their father to be buried in Hungary if order were not restored. Then the students enrolled themselves as a "Guard of Order," and every preparation was made to receive Kossuth's body with great honors. The patriot's remains left Turin amid every sign of respect, and were taken to Pesth to rest by the side of his wife and daughter.—*The Graphic.*



LOUIS KOSSUTH.
Born 1802. Died March 20, 1894.

## DUCK FATTENING IN ENGLAND.

AMONG the smaller rural industries of England that of rearing and fattening ducks is one of much interest, and also one that might be made of greater importance. In the country around Leighton Buzzard, in the counties of Beds and Bucks, this business has been pursued for a number of years, those engaged in it being chiefly cottagers. The accommodation required is not extensive, nor can the initial capital be large, at least so far as money is concerned, though the capital represented by time, trouble and careful attention must be far from insignificant.

The Aylesbury duck is the breed employed, and, as a rule, the ducks which are reared and fattened are not bred on the establishment. The custom is for the fattener to buy his eggs from people in the neighborhood and hatch them under hens. Some trouble is taken to secure an adequate contingent of sitting hens at the time the eggs are ready, and the people engaged in the business are fully alive to the advantage of getting the fat ducklings early to market. The game season ends in February, and from then to the reopening of the shooting season in August is the time when fat ducklings make their market. Prices are highest in February and March, being then from 14s. to 16s. a couple, and gradually decreasing to 5s. or 6s. in July, on the London market, the average dead weight of the birds being about 6 lb.; dressing to 4½ lb. After hatching out, the young birds remain for a week with the hen, and are well fed on boiled egg and other dainty morsels. With other birds of the same age they are then drafted into a "flock" of 100 to 125 birds. At this age they are exceedingly pretty objects—little animated balls of yellow down, with heliotrope colored bills and a plaintive chirp. As they get older the feathers become white and the bills grow paler. On a single duck "farm" numbers of flocks may be seen of one, two, three or more weeks old, and this classification is the only one adopted, as all the birds are destined to be killed at eight or nine weeks old.

Good rice, either Rangoon or stained Japan, at about 16s. a cwt., is the chief food of the younger birds and is boiled for use. They are also very fond of toast soaked in water. Later on barley meal and toppings, or sharps, are introduced; and when the birds are five weeks old they also get greaves or tallow scrap, which is boiled up in the food, into which stinging nettles

chopped and boiled are introduced, as they are said to cool the blood.

The ducklings are fed thrice a day—at 7:30 A. M., 12:30 P. M. and 4:30 P. M. They are never allowed to roam at will or to go on water, though a pail of water is allowed them for washing purposes. Special care is taken in securing suitable grit to go in the drinking water. The local gravel has no clay with it and will not bind, but suitable gravel can be bought at Long Marston at 1s. 6d. a load.

Recently a party of gentlemen interested in the subject visited the Leighton Buzzard district, among them being Mr. C. E. Brooke (master of the Poulters' Company), Mr. A. E. Brooke-Hunt, of the Board of Agriculture, Mr. Edward Brown, Mr. R. L. Everett, M.P., Mr. E. Glaisyer and Prof. Wallace.

At one of the farms inspected the party saw 2,000 ducklings at one view. Very commonly a low, warm shed, with a space of ground in front of it, was all the room the birds were allowed. By means of 12 in. planks placed edgewise the inside of the shed can easily be divided into rectangular compartments, each holding 100 birds; crowding is thus prevented. They are all let out in one big flock for feeding and exercise, but on their return they are penned off in the manner stated. On one of the smaller duck farms 1,800 birds were plucked last year; on the largest visited the number was 10,000. On this latter place it was computed that for every 100 birds hatched out 85 are ultimately marketed. Deaths are most frequent when the birds are very young. At the height of the hatching season as many as 200 or 300 hens will be sitting on one farm; clucking hens cost as much as 4s. each early in the season; but the price gradually falls to about 1s. 9d. By midsummer the whole stock of ducklings is cleared off, and there are none on the place till the earliest arrivals of the next season make their appearance. In the three or four months' interval the duck houses are cleaned, whitewashed and sweetened in every way. During the whole fattening season, however, considerable care has to be taken in keeping the surroundings healthy. Among the ailments of the birds is "soft bill"—so soft sometimes, it is said, that the young birds cannot break their way out of the shell. It is very probable that this evil is a result of too close breeding, and from observations which were made recently it would appear that a little technical instruction and a few investigations upon this and allied matters would be of considerable value to those engaged in this minor industry.

## THE CLIMATIC AND NATIONAL ECONOMIC INFLUENCE OF FORESTS.*

IT is to German scientific men that we owe the first steps taken in order to ascertain data concerning the actual climatic effects of forests. Since then, however, most civilized countries except Britain, have been actively engaged in the collection of actual data concerning this very important subject. So far as those data have yet been collated and compared, they lead to the following results.

It was not until the year 1867 that exact scientific observations were undertaken on an extensive scale to determine the actual influence which forests have in modifying the temperature of the air and of the soil within their own areas and over the surrounding tracts of country, and the first results were published in Ebermayer's celebrated work, *Die physikalischen Einwirkungen des Waldes auf Lufte und Boden*, 1873.

1. *As Regards Atmospheric Temperature.* — The average results of observations made during ten years (1876 85) throughout nearly the whole of Germany, and in parts of France and Switzerland, in different kinds of forest, at heights above the sea level varying from 10 to 3,000 feet, and at latitudes varying from 47½° to 55¼°, prove conclusively that in general the annual average temperature within forests growing in closed canopy is lower than in the open, although the crowns of the trees are on the whole a little warmer in winter. The difference is greatest in summer, least in winter, and about midway between these extremes in spring and autumn; the mean annual difference, however, seldom amounts to over 1° Fah. near the ground, and is scarcely ½° in the crowns. The prevention of insolation of the soil during the long hot days of summer, and the rapid transpiration taking place through the foliage, exert a greater influence on the atmospheric temperature than can be ascribed to shelter from wind and to decrease of nocturnal radiation.

The observations recorded prove (1) that the variations between the temperatures of the trees themselves and the air in the open exceed those between the woodland air and the latter except during winter, (2) that they are largest during the most active period of vegetation in summer, and (3) that they are greater in spring, when the circulation of sap begins, than during the autumn months, when vitality becomes sluggish and dormant.

In the crown of the trees, where insolation by day and radiation by night make their full influence felt, the difference in the daily average over the whole year is less than it is near the ground. In winter it averages little either above or below 0°, and in summer usually about the half of the reading at 5 feet above the ground.

Observations made in Southern Germany establish the fact that in the forests it is cooler during the day and warmer during the night than in the open.

During the night the trees interfere with the radiation of heat, and in the day time the shade afforded by the crowns keeps the air from being rapidly warmed by the sun's rays. These influences are naturally strongest during spring, summer and autumn, when foliage is most abundant, while in winter the coniferous forests with evergreen foliage are milder than deciduous forests.

Owing to these differences in temperature, beneficial currents of air are induced between the forests and the open country, which follow the same law as obtains in regard to land and sea breezes. During the day the cooler and moister air of the forest sets outward to take the place of the heated air ascending in the open; at night the current sets in from the open, cooled by radiation, toward the forest.

* From *Nature*.

The statistics, upon which these deductions are based, prove that the immediate action of forests is to modify the daily maxima and minima of atmospheric temperature, whence it may be deduced that a comparison of the absolute extremes of temperature during the year must exhibit definitely the sum total of the influence exerted by forests on the temperature of the atmosphere. The modification of the extremes of temperature, which are had alike for man and beast, and also for agricultural operations, is of immense importance from a national economic point of view, since many places that were once fertile are now little better than barren wastes in consequence of the reckless denudation of forests.

In registering the data, however, it was observed that the geographical position, and the exposure of the forests to winds, exerted a certain amount of modifying influence in lessening the differences, and there are reasons to believe that toward the crown the forest temperature in winter is considerably higher than down nearer the ground. It was found, too, that certain forest trees exerted greater influence than others in consequence of the density of their foliage; for beech forests in summer exert, through their dense foliage and complete canopy, a considerably greater influence in diminishing the extremes of temperature than forest of spruce or Scots pine, although after defoliation their influence is merely similar to that of the pine forest, and only half so great as that of the more densely foliaged spruce.

2. *As Regards Soil Temperature.*—The influence exerted on the soil temperature by forests growing in close canopy is of considerable importance, especially with regard to the soil moisture. The observations made concerning this point seem to make it clear that the mean annual temperature of the soil in the forest is at all the above depths of observation cooler than in the open, and that the differences are greatest in summer, about the mean in spring and autumn, and very small in winter. In countries with warm summers this reduction of the soil temperature over large areas by means of forest growth has a decidedly beneficial result. According to observations made in Wurtemberg, the difference between the maxima of soil temperature in forests and in the open can extend so far as up to 14° Fah.

It was also found that the daily differences in soil temperature varied according to the season of the year, but that throughout nearly the whole year the upper layers of soil in the open were warmer in the afternoon than in the forenoon, whereas in the forest the variations were inconsiderable.

As with regard to the atmospheric temperature, the influence of the forest trees in equalizing the soil temperature throughout the year is greatest in the case of trees whose foliage is densest, spruce heading the list.

3. *As Regards the Degree of Atmospheric Humidity.*—Observations recorded throughout Central Germany show that *as regards the absolute humidity of the air* forests have no appreciable climatic effect, for the annual averages showed merely slight traces of differences at 5 feet above the soil.

*The differences between the relative humidity of the air in forests and in the open are*, as might be expected, greatest in summer, although very different results as regards variations are obtained with changes of altitude and of other physical conditions.

The results of the various series of observations, corrected so as to eliminate, so far as possible, local differences due to altitude and other physical dissimilarities in the various meteorological stations, show that the mean annual relative humidity of woodland air is from 3½ to 10 per cent. greater than that of air in the open, but that the difference varies greatly according to the season of the year, being greatest in summer and autumn, and least in winter and spring. They show, too, that large areas covered with spruce will be moister as well as cooler than those under woods of less densely foliaged species of trees. In Bavaria it was found that in summer, in consequence of the density of the foliage in beech forests during the most active period of growth, the difference even amounted 13·6 per cent. of saturation over the relative humidity in the open.

4. *As Regards the Precipitation of Aqueous Vapor.*—It has been shown above, not only that the atmosphere within the forest is cooler than in the open, but also that the temperature of the trees themselves is lower, especially in summer, than the air surrounding them; hence, when a current of air is wafted from the open into the forest, and comes in contact with the cooler trees, its temperature is reduced, and it is brought nearer to the point of saturation, *i. e.*, its relative humidity increases. But if this air was already in the open at, or near, the point of saturation, then the effect of the cooling process is that a certain amount of surplus moisture beyond the aqueous vapor that can be held by the air up to a point of saturation at its reduced temperature must be released and precipitated in the form of dew. Woodlands, therefore, act as condensers of atmospheric moisture, and decrease the absolute humidity of the air while increasing its relative humidity; and, in addition to this, they increase the humidity of the air by transpiration from the leaves, while the sap is being rendered available for structural purposes, and the work of assimilation is proceeding.

Endeavors have been made to establish, by means of careful observations, the effect of forests in regard to the precipitation of aqueous vapor in the form of dew or rain, but the results are often of so conflicting a nature that, up till the present, safe deductions cannot be drawn. In order to compare observations made in the forests with those made at the usual meteorological stations in the open, a correction would in each case be necessary to reduce the localities to the same sea level, as air cools in rising and increases in relative humidity, *i. e.*, it approaches the point at which it must precipitate some of the aqueous vapor held by it. Hence rainfall generally increases with the height of a locality above the sea level, although no direct proportional increase can be proved. It fluctuates with the geographical position and the varying physical conditions of each point of observation, while variations in the direction of the moist winds of the locality also militate against the collection of reliable data for comparison with readings made in other localities.

The mean of the readings at 192 points of observation in Germany, corrected as carefully as possible with reference to these causes of difference, do not seem capable of giving any more exact inference than the general statement that at high altitudes large extents of forest may considerably increase the local rainfall. As regards the quantity of rainfall and snowfall which is intercepted in forests by the leaves, branches, and stems of the trees, the observations made in Switzerland, Prussia, and Bavaria show that nearly one-fourth of all the precipitations of aqueous vapor is intercepted by the forest trees, and is given off again by evaporation, or is gradually conducted down the stems to the soil. In lofty forest-clad regions the mechanical action of the rains on the surface soil is thus very much modified.

By means of their lower temperature, their greater relative humidity, and the mechanical obstruction they offer to the movements of currents of air, extensive forests act decidedly as condensers of the aqueous vapor contained in the atmosphere, and their influence in this respect is more marked at high altitudes and in mountainous districts than on plains or near the sea coast, where other physical factors come into competition with and modify it. Further data are still requisite to enable us to determine with anything like certainty that forests directly cause increase of precipitations irrespective of such local considerations as the ruling direction of winds and peculiarities of situation; the generally accepted dictum is, however, that in the vicinity of extensive forests the rainfall is greater than at other localities under otherwise similar physical conditions.

In portions of the Russian steppes, planted nearly fifty years ago, the inhabitants assert that the summer rainfall has considerably increased, and that the danger to crops from drought is not so great as formerly, while the villages are also protected by the forest from the violence of the winter storms.

In summarizing and criticising this point Prof. Endres, of Karlsruhe, remarks as follows:*

"The data furnished from tropical countries must be accepted with the greatest caution, and in any case they afford no conclusive deductions for European circumstances. Blandford reports from India (*Meteorological Journal*, 1888) that in an area of 61,000 square miles, which was formerly denuded of woodlands, but has been planted again from 1875, the rainfall has increased twelve per cent. since then. But H. Gannet (*Weather*, vol. v.) arrives at exactly the opposite conclusions for America, as his observations in the prairie region and in Ohio go to prove that the rewooding of a tract exerts no perceptible difference on the amount of the aqueous precipitations. Lendenfeld also tries to prove that the clearance of woodlands in Australia has resulted in a better climate and an increase in rainfall, as the soil under eucalyptus remains hard as stone and inabsorptive, while it is rendered lighter and more porous by grass. (*Petermann's Geog. Mittheilungen*, vol. xxxiv.)"

5. *As Regards Evaporation of Soil Moisture.*—The low temperature and the high relative humidity of the atmosphere in forests are unfavorable to rapid evaporation, which is still further reduced by the protection afforded to the soil against direct insolation and the action of winds. From observations extending over ten years (1876–85) in various parts of Germany and Austria, the following relation is shown between evaporation in the forests and in the open in the vicinity of the forests; the differences would probably be greater if comparisons had been made with places in the open that were far removed from the modifying influence of the woodlands.

| | Water Evaporated. | |
|---|---|---|
| In the open . . . . | 20·9 inches. | The practical importance of this will be seen when it is recollected that the mineral food in the soil can be taken up by the rootlets only in the form of *soluble* salts. |
| In the forest. . . . . | 9 5 " | |
| Lower in forest than in open by.. | 11·4 inches. | |
| Evaporation in forest expressed in percentage of that in the open.. | 46 per cent. | |

It was also found that the amount of evaporation depended on the class of forest, thus:

| Species of Woodland. | Percentage of Water. | |
|---|---|---|
| | Evaporated in the Forest. | Remaining in the Soil. |
| Beech . . . . . | 40 | 60 |
| Spruce . . . . . | 45 | 55 |
| Scots pine . . . . . | 42 | 58 |
| Clearing for reproduction. . . . . | 90 | 10 |

In these statistics no account has been taken of the quantity of water given to the air by transpiration through the leaves; but this is not of essential importance, as such supplies of moisture are drawn by trees, except during the earliest stages of growth, from the deeper layers of soil and subsoil not immediately and directly affected by the aqueous precipitations on the surface. This may be less true of spruce than of other trees.

The action of forests, therefore, is to retain in the soil a large proportion of the rainfall or of the moisture arising from the melting of snows, which, by percolation to the lower layers and the subsoil, tends to feed

* Conrad, Elster, Lexis, and Loening's "Handworterbucb der Staatswissenschaften," 1892, vol. iii., page 608.

the streams perennially, and to maintain a constant supply of moisture, without which trees could not derive their requisite food supplies from the soil.

The nature of the soil covering below the forest trees exerts also considerable influence on the amount of moisture evaporated. From experiments conducted during five years in Bavaria it was found that a good layer of fallen leaves, and of *humus* or vegetable mould formed by their decay, is a powerful factor; it diminishes the evaporation by more than half, or reduces, it to less than one-quarter of that in the open, and thus adds very considerably to the surplus amount of moisture retained in the soil.

6. *As Regards the Feeding of Streams and the Protection of the Soil.*—From the above data it seems evident that the effect of extensive forests, more especially of those situated at high altitudes, is, by cooling the air and reducing its capacity for retaining aqueous vapor, to increase the precipitations. While these precipitations are taking place the crowns of the trees intercept a large proportion of the total, and by breaking the violence of the rainfall protect the soil from the danger of being washed away during heavy storms. By the decomposition of fallen leaves and twigs a strongly hygroscopic soil covering is formed, capable of imbibing and retaining moisture with sponge-like capacity. Rapid evaporation of the soil moisture is counteracted through the protection afforded by the foliage against direct insolation during the day, and by the mechanical hindrance offered to currents of wind. The crown of foliage likewise prevents the soil cooling rapidly at night by radiation. The hotter the summer, the more marked are these beneficial effects of the woodlands.

When, therefore, large tracts of country are denuded of timber, increase of temperature during the days of summer, rapid radiation of soil warmth by night, diminished precipitations (especially in the spring and summer), and unchecked evaporation of moisture, due to complete insolation of the soil by day and absence of any protection from winds, must be the inevitable consequences. Examples of such actual results can be pointed out in many parts of continental Europe, in Western Asia, and throughout India. In Great Britain and Ireland the effects of the wholesale clearance of woodlands have not been so marked, in consequence of the favorable influences exerted on our climate by the Gulf Stream.

In localities having no protective woodlands heavy rains wash away the surface soil, torrents and freshets rush down the watercourses with great violence, laden with detritus and discolored with the soil held in mechanical solution, while streams and rivers often overflow their banks in consequence, devastating large areas of low-lying tracts under cultivation. Forests, on the other hand, tend to break the violence of the rainfall, and retain for the time being about one-fourth of the total amount on the foliage and branches; the roots of the trees and of the undergrowth help to bind the soil firmly; the rainfall is retained by the vegetable mould and by the spongy growth usually found on the surface soil, and thence gradually percolates to the deeper layers, where it is held in reserve, to be finally parted with in being utilized for the feeding of perennial streams having their sources on the wooded slopes.

Thus arose in the Alpine districts of southern Europe the necessity for maintaining *ban-forests* as a protection against landslips, avalanches, etc., and legal measures were early adopted for safeguarding them in order to protect the lower tracts from erosion of the soil when sodden with rainfall or melted snow.

7. *As Regards General Hygienic Effect on the Atmosphere.*—It is well known that on the one hand when large tracts of forests are cleared for cultivation, especially in tropical and subtropical countries, fever and ague are frequently the consequence, and on the other that the planting of notorious fever districts, such as the Campagna di Roma, the Tuscan marshes, and the Russian steppes, has decidedly diminished the insalubrity of these localities. But the causes are very probably rather due to the degree of direct insolation of the soil, freely afforded in the one case and counteracted in the other, than to any hygienic property inherent in tree growth. In the latter case, too, stagnating surplus of soil moisture may have been got rid of by transpiration through the foliage, and this would of itself go far toward removing causes of insalubrity, and improving the climate.

It is generally accepted that ozone kills miasma in the air, and purifies it; at any rate, impure air contains little or no ozone; the proportion of ozone is, therefore, usually taken as the measure of atmospheric quality. The belief that the woodland air is, like sea air, very rich in ozone, has not yet been satisfactorily proved. Experiments in Bavaria showed that in the forests the percentage of ozone, though greater than that in the vicinity of towns, was slightly less than in the open in the vicinity of forests, and that there was no perceptible difference in this respect between coniferous and deciduous forests.

The woodland air was found to contain most ozone in winter, which shows that its production could not be due to any chemical action of the foliage, for there are no leaves on deciduous trees at that season, while conifers transpire merely, and do not assimilate. It also indicates that the excess is probably due to the comparative freedom of air in the forest from the smoke, carbonic acid, and many other impurities with which air in the vicinity of towns is contaminated and defiled, and to the withdrawal of enormous supplies of oxygen from the air which takes place for the support of animal life at all populous centers. Thus, while in general the quantity of carbonic acid in the atmosphere is somewhat under four volumes in 10,000, that is the normal amount in London air; but in thick fogs this proportion is frequently doubled, and has been known to be more than trebled, or even to exceed fourteen volumes in the city.

Sunlight, however, has the power of decomposing carbonic acid in the presence of chlorophyl, the green coloring matter contained in foliage, the carbon being absorbed by the plant for its growth, and the oxygen set free. During darkness a contrary action takes place, oxygen being consumed by the foliage, and carbonic acid given off. As, however, particularly in the case of deciduous trees, which are in leaf only from April till October, the hours of light far exceed in number those of darkness, the general hygienic effect of trees in cities and towns—apart from their invaluable æsthetic influence—tends decidedly toward the purification of the atmosphere from excess of carbonic acid.

Ozone, again, is an allotropic modification of oxygen obtainable by passing a series of electrical discharges through it; hence it is more than probable that in forests in exposed localities, more especially those at high altitudes, where storms and electrical disturbances of the air are most frequent, a greater quantity of ozone must be generated in the atmosphere than in localities less subject to such powerful ozonizing influences.

Ebermayer, undoubtedly one of the greatest authorities on this subject, says:*

"In the middle of the great 'ozone factory,' which we must consider the forest to be, neither more oxygen nor less carbonic acid is offered to mankind for breathing than over large unwooded areas."

At another part of the same article he also adds:†

"From the hygienic standpoint, it is worthy of notice that, according to my examinations, the air in and immediately above the crowns, then that in the immediate vicinity of the forests, has more ozone than that in the interior of the forests, where a portion of the ozone is consumed by the decomposing foliage lying on the ground."

It appears, therefore, to be his matured opinion at present that while more ozone is found in forests than in the open—which the Austrian students of the subject deny, or, at any rate, are not yet prepared to admit without further observations and proofs—yet the decomposing matter covering the soil consumes the surplus, and often more than that, so that no difference can be established in favor of the forest air. In this withdrawal of ozone in excessive quantities from the air by decomposing vegetable matter, the unhealthiness of tropical jungles, and the prevalence of malaria at all the lower elevations within the tropics usually covered by woodlands, seem easily explainable.

According to Endres and to Fernow,‡ it is claimed that forests tend to resist the spread of epidemics, and to offer a bar to the progress of diseases like cholera and yellow fever.

Regarding the sanitary influence of forests, the latter states (*op. cit.* p. 21) as his summary that "(1) the claimed influence of greater purity of the air due to greater oxygen and ozone production does not seem to be significant; (2) the protection against sun and wind, and consequent absence of extreme conditions, may be considered favorable; (3) the soil connections of the forest are unfavorable to the production and existence of pathogenic microbes, especially those of the cholera and yellow fever, and the comparative absence of wind and dust, in which such microbes are carried in the air, may be considered as the principal claim for the hygienic significance of the forest."

Fortunately, there are not many infectious diseases the germs of which can be carried by water; as yet, only two are known with certainty, cholera and enteric fever. When outbreaks of these diseases occur in tropical countries, the infectious power of the germs is favored by warmth and moisture; moreover, when epidemic, these diseases usually break out in thickly populated towns and similar localities, where it is impossible to submit the soil moisture or the water supply to the filtrating action of belts of woodland.

8. *As Regards the Agricultural Productive Capacity of Neighboring Tracts, and the National Economic Effect on the Soil Generally.*—From an agricultural standpoint, a dry season is much preferable to a low temperature and excessive rainfall. In the former case the crops, although they may be somewhat scanty, are invariably of superior quality. A wet season may produce abundant crops, but they are generally of low quality.

With regard to the influence of forests on the aqueous precipitations throughout central Europe, Prof. Endres makes the following remarks:§

"The question whether woodlands can influence the rainfall is one of the most important from a national economic point of view. Even if this could be distinctly affirmed, the beneficial action of forests would only be established in the rarest cases, for throughout central Europe at present the number of too wet years exceeds that of dry years. *In districts where the rainfall is over 40 inches, any increase is undesirable.*‖ For agriculture very dry years are on the whole less disastrous than extremely wet years. The precipitations of any district are influenced mainly by the position of the mountain ranges with reference to the cardinal points of the compass, by its elevation above sea level and its distance from the sea."

But, as the American investigations prove (*idem.* p. 13), "no influence upon the general climate which depends upon cosmic causes can in reason be expected from a forest cover. Only local modifications of climatic conditions may be anticipated, but these modifications, if they exist, are of great practical value, for upon them rest success or failure in agricultural pursuits, and comfort or discomfort of life, within the given cosmic climate. The same condition must be insisted upon with reference to forest influences upon waterflow, which can exist only as local modifications of water conditions, which are due in the first place to climatic, geologic and topographic conditions."

Even so early as in Roman times it was recognized that too great a clearance of woodland areas brought undesirable changes in the physical conditions of Italy, and affected the welfare of the inhabitants. That the destruction of the ancient forests throughout Great Britain and Ireland, to such an extent that only 3·8 per cent. of the totel area can now be classified as woodlands (*vide* Parliamentary Report on "Forestry," dated August 5, 1887), was not followed by such disastrous climatic changes as were occasioned by similar causes throughout the Landes, Syria, Asia Minor, Greece, Russia and many parts of India, we owe entirely to our insular position with its moist climate, and to the happy effects wrought by that portion of the Gulf Stream which reaches our western and southern shores.

Early in the present century, for example, the Agricultural Society of Marseilles reported that in consequence of the reckless destruction of the forests after the revolution of 1789:

"The winters are colder, the summers hotter, and the beneficial spring and autumn showers no longer fall; the Uveaune, flowing from east to west, rushes down in flood with the least rain, carrying away its banks and flooding the richest pasturage, while, for nine months of the year, its bed lies dry, owing to the drying up of the streams."

To a similar cause also Prof. Geffcken (in *The Speaker* of January 6, 1893) attributes the Russian famine of 1892 in the following terms:

"We speak of the deficit (in the Russian Budget) of 1893 as certain, and it is easy to show that it will be so. *The principal cause of the present dearth is the drought during the last spring and early summer, and this absence of rain is greatly due to the devastation of the forests.* The area formerly covered with timber was enormous, the woods belonging to the crown, to the great landed proprietors and to the village communities. But the means of transport were then so imperfect and costly that only in the neighborhood of large rivers did the felling of timber pay. This changed with the construction of railways and the abolition of serfdom; the former gave the possibility of selling with profit, and the peasants abandoned their woods to speculators for what they thought a good price, little thinking of the future; the larger proprietors followed their example; the purchase money was spent in drink and luxurious living, and no one thought of replanting. *Too late has the government issued a law for the protection of forests. Such a devastation going on for twenty years not only exhausts a source of wealth, but has also other bad consequences.* When the country is deprived of its trees, the earth is dried up and crumbles from the hills; the water coming down from heaven cannot be kept back, as is the case with the woods, which act as a sponge, but rushes in torrents into the rivers and disappears in the sea, and the consequence is a gradual diminution of the fertility of the soil and the disappearing of numerous brooklets and small rivers, to help the larger ones show a low water mark, which proves prejudicial to the navigation."

This view is confirmed by the special correspondent of the *Times* (*vide* article "Through Famine-stricken Russia" in issue of April 18, 1892), who writes:

"I have now traveled over most of the famine-stricken provinces, and I have been struck by the sameness of the picture. Everywhere reckless extravagance meets the eye, the forests have been cut away wantonly, the rivers are neglected, the climate is ruined."

Such also appears to have been the opinion of Major Law, Commercial Attache to the British Embassy at St. Petersburg, as expressed in his "Report on Agriculture in the Southeastern Provinces of European Russia," commented on in a leading article of the *Times* of September 17, 1892, in the following words:

"It is said that this gigantic natural tillage farm (*i. e.*, the 'black soil' region) was formerly hedged in by belts of forest, which served the twofold purpose of sheltering it from the desert winds and of increasing the humidity of the climate. It is certain that these forests do not now exist, and that the black soil country is often scourged by devastating blasts from the steppe, and not infrequently baked by prolonged droughts. The desert winds pile the snow in drifts in winter, which become the source of destructive torrents in the spring. In summer the same winds are so fierce and arid that in the space of a few hours they wither the corn as it stands, while, when they are laden with sands, they smite the soil with perpetual barrenness."

All writers, indeed, who have recently published views on this subject, seem agreed as to the main causes of the recent Russian famine.*

In order to obtain the full national economic benefits that are derivable from woodlands, the areas reserved as forests or planted up should be scattered over the face of the country as equally as possible. In all countries where the population is thin, and primeval forest is still to be found, measures with this end in view can easily be carried out without inflicting any apparent hardship on the existing community. But wherever danger from famine is apt to recur from time to time, it would at the same time seem to be worthy of consideration whether it would not be wise to expropriate tracts of the poorer and higher land here and there, and plant them up on a well considered scheme for the purpose of ameliorating the climatic conditions for man and beast in the future.

J. NISBET.

* "Hygienische Bedeutung der Waldluft und des Waldbodens," in vol. xiii. of "Forschungen auf dem Gebiete der Agricultur-Physik," edited by Prof. Wollny, 1890, p. 429.

† *Op. cit.*, p. 435.

‡ "Forest Influences," p. 172, 1893.

§ "Hygienische Bedeutung der Waldluft und des Waldbodens" in vol. xiii. of "Forschungen auf dem Gebiete der Agricultur-Physik," edited by Prof. Wollny, 1890, p. 607.

‖ This is a point of very great importance with reference to the proposals of Mr. Munro Ferguson, M.P. (*Contemporary Review* for October, 1892, pp. 521, 522), for planting up the Highlands of Scotland, and Dr. Macgregor's three questions in the House on the same subject on November 13, December 12 and December 19, 1893. For if there be already any tendency toward more rainfall during the summer months than is good for agricultural crops, an extensive increase in the acreage of woodlands in such vicinities is not desirable.

* See also the article on "The Penury of Russia" in the *Edinburgh Review* for January, 1893 (pp. 17-19), which may be said to contain a summary of the best opinions on the matter.

## ON THE UPPER PENINSULA OF MICHIGAN.

By WILL. FARRAND FELCH.

IT is now two centuries since civilized men first penetrated the vast solitudes of the Lake Superior region. The history of the early explorations, missions, and settlements is full of deep, romantic, thrilling, and sometimes tragic interest.

The site of Marquette was not prominent at an early day, but the city is now the metropolis of the Lake Superior region, having far outstripped her elder sisters in population, wealth, and business. For the first half of its progress Marquette was essentially French in all its characteristics.

The French Jesuits, with firm step and intrepid mien, facing dangers, suffering, and sacrifices, bore aloft the Christian cross and welcomed even torture and death with a calm resignation which distinguished the followers of Loyola. Their deeds and memories are embalmed in the pages of Bancroft and Parkman.

The arm of French power soon taught the savages the sacred character of the "Black Coats"—as the Jesuits were called to distinguish them from the "Gray Coats," or Recollets. The patience and perseverance of the missionaries overcame all opposition, and the Huron nation received the truth; but the

terrible Iroquois—the "Romans of the West"—came down upon the Hurons like wolves upon the fold; the Hurons were destroyed as a nation; some fled to Mackinaw and others to the Bay de Noquettes, near Escanaba, while others gathered around the standard of the cross established by Father Allouez at La Pointe in 1665. Driven thence by the Dakotahs, they were established by Father Marquette in 1671. When Detroit was founded, in 1701, many removed thither, and others to Sandusky, where they were known as Wyandottes.

Father Mesnard was selected as the first missionary to visit Lake Superior—the shores of "Gitchie Gumee" or "The Big Sea Water." The choice was a fit one. Alone, in 1660, he left the haunts of civilization, and put himself in the hands of savages, who treated the aged priest with coarse brutality, compelling him to ply the paddle and drag the canoe up foaming rapids, or carry it across long portages. Finally he was left barefooted, exhausted, without food or means of procuring it, on the shores of Lake Superior to die. After a few days, during which he subsisted on pounded bones and other refuse, they returned for him.

Here, amid every discouragement and privation, with no white brethren nearer than Montreal, Mesnard began a mission and said mass. We cannot linger over the story of want, famine, and cold, which came to them, making memorable this effort to establish the cross by the waters of "Gitchie Gumee." Longfellow has immortalized it in his "Hiawatha:"

O the long and dreary winter!
O the cold and cruel winter!
Ever thicker, thicker, thicker,
Froze the ice o'er lake and river,
Fell the snow o'er all the landscape,
Fell the covering snow and drifted.

O the famine and the fever!
O the wasting of the famine!
O the blasting of the fever!
O the wailing of the children!
O the anguish of the women!
All the air was sick and famished;
Hungry was the air around them;
Hungry was the sky above them;
And the hungry stars in heaven,
Like the eyes of wolves glared at them.

The next year the missionary was sent to the Bay de Noquettes, and started in August, 1661. While his attendant was getting the canoe over a portage he wandered into the forest, and was never seen more. Whether he was lost in the wood or struck down by a straggling Indian was never known. In 1665 came Father Claude Allouez, and soon after came Father Marquette, whose history is too well known to need extended mention. His grave, at Point St. Ignace, opposite Mackinac Island, is a point of historic interest.

It is probable that the French fur traders had penetrated the wilderness prior to the missionaries. The immense profits of this trade excited the cupidity of English traders in New York City, and for nearly a century the English spared no pains to gain control of the trade. The French, on their part, employed agents to go among the Indians in order to maintain an influence over them. One of these was Captain Duluth, who was stationed at Sault Ste. Marie as early as 1679. He erected a fort at La Pointe, and in 1686 the fort of Detroit, where Fort Gratiot now stands, at the foot of Lake Huron.

The knowledge of minerals was almost contemporaneous with the discovery of Michigan. As early as 1659-60 the Jesuits reported lead and copper on the shores of Lake Superior. The first attempt at mining was made after the conquest of Canada by the British. A Mr. Henry, in 1765-66, found at Ontonagon an abundance of virgin copper, and application was made to George III. for a grant of all the copper mines within sixty miles of Lake Superior. The grant was made, but never issued out of the seal office, as a company was formed of nobles and nabobs, headed by the Duke of Gloucester, and a company of miners came out in 1770, spending the winter at the Sault and at Point aux Pines, a few miles above. They built a barge of fifty tons capacity, and in May visited the "Island of the Yellow Sands," but found no gold, as they expected. They found copper and lead ore, and erected a furnace at Point aux Pines. But they found the mining impracticable, and soon came back. Thus ended the first systematic effort at mining, and nothing more was done until 1843.

When Michigan became a State, in 1837 the only settlement on Lake Superior within its bounds was at the Sault, which had a population of 368. In 1820 Schoolcraft described it as a place consisting of fifteen or twenty buildings occupied by French and English families. It is not more than twenty-five years ago since the first iron ore was taken from what is known as the Jackson location, at Negaunee, when less than half a ton was packed on the backs of mules and halfbreeds to the mouth of the Carp, from thence in canoes on the St. Mary's River, and pronounced worthless on its arrival in Detroit. Less than a quarter of a century ago the district which furnishes one-third of all the iron ore in this country, furnishing ore for 150 furnaces, was an unexplored wilderness. Now the county of Marquette alone, which contains nearly all the iron mines, boasts of a population of over 25,000. It has an area of 2,176,000 acres.

As might readily be inferred, the most important manufacturing interest in the Lake Superior region is the smelting of ores. The attempt to establish iron manufactures was made under very discouraging circumstances, before anything had been done to develop the mines, and when it would have been next to impossible to get the iron to market. It succeeded only so far as to show the sterling qualities of the ores and the readiness with which they could be converted into blooms and pig iron.

The largest portion of the ore goes to Cleveland and Pittsburg, and into the coal fields of the Mahoning and Shenango valleys. About one hundred furnaces in Ohio and Pennsylvania use Lake Superior ore. The freight by water is only 50 cents a ton, even from Escanaba, while from Cleveland to Youngstown it is $1 and to Pittsburg $2.

The stocks of the iron mining and smelting companies are not in the market, the owners being perfectly satisfied to keep them, as they pay dividends when working. And now a word about the region about Marquette and throughout the county of the same name.

The city of Marquette is situated on Iron Bay—a gem compared to the Bay of Naples by many. The harbor is nine hundred feet above the level of the sea, and is alive with all manner of steam and sailing craft, which annually bear away over a million tons of ore. Listen to the continual rumbling of the ore trains as they swiftly follow one another through the heart of the city and out upon the great trestle docks, into the pockets of which they deposit their burdens, and from whence it is poured into the holds of vessels alongside. See, in front of the city and along the lake border, the blaze of great furnaces, roaring day and night, to reduce the ore for market. See, also, the extensive wharves, loaded with thousands of tons of coal and merchandise for home consumption. Then turn and behold the fair city itself, the growth of only a few years, with its fine red stone churches, elegant residences crowning the cliff, substantial banks, convenient schools, and, above all, its pure, bracing air. The stranger arriving in Marquette at night would have no difficulty in believing it a stirring business town. A lighthouse sits at the entrance of Iron Bay, at the end of a breakwater a thousand feet long studded with numerous lights. The piers are aglow with gas and electric lights, and every vessel has a lamp swaying in its rigging, while at the right and left of the bay two gigantic blast furnaces send forth a flickering but steady flame. Here are located the United States custom house, the United States land agency, two rolling mills, car shops, and roundhouses, while outside the city are a dozen tracks, each loaded with great trains of ore from the mines, numbering nearly a thousand cars. There are several banks, good hotels, a number of fine museums of curiosities from the vicinity, and busy stores, and saloons without number.

The people of Marquette are well favored with the grand in nature, hills and valleys encompassing it, the swift-flowing river, the expanse of lake and stretch of shore line, while opposite the bay is the famous Presque Isle, and forty miles eastward are the "Pictured Rocks," well worth coming this far to see.

Bidding adieu to Marquette for a tour of the iron mines, the train toils up a steep grade from the lake level to the heights of the Iron Range, stopping at the three or four blast furnaces before reaching Negaunee, twelve miles distant, the site of the first iron mines discovered. South of the city is an elevation, called a mountain, where the hematite or the yellow ore is located. This ore is easily mined, readily shoveled, but of a lean nature—that is, averaging but 44 to 55 per cent. of iron.

Iron mining is conducted on the same principle as quarrying, and the veins in the hills vary in width, from an opening in which a man can stand to one which would contain a regiment, or a cathedral. The veins dip at regular angles generally, never perpendicular. At the first opening of a mine the ore is deposited in a "stock pile." As the mine progresses in depth inclined tramways are built, traversed by cars of boiler iron, shaped like a coal scuttle, called "skips." From these the ore is dumped into cars running on a trestle to the stock pile or to the railroad cars.

The miners work in gangs of three, and are paid by the cubic foot or fathom, by contract or by the ton The captain of the gang starts his drill into the face of the iron wall, into which it is driven by the sturdy blows of his stalwart helpers. When a number of holes are made a blast of giant powder completes the work. These blasts are made four times a day, and are very dangerous to life and limb, resulting in cracked skulls, broken limbs, sprains, and contusions. The miners are taxed $1 a month for doctor hire. They receive $1.50 to $1.80 per ton for mining hard ore, and some as low as $1. This is very cheap compared with what coal miners receive. Hard ore, suitable for Bessemer steel, brings $5.50, where it formerly brought $10 and $11 a ton; but the iron interests are slowly improving.

Ishpeming, three miles from Negaunee, contains the largest mines—the Lake Superior, Cleveland, New York, Barnum, and others. Beyond these towns lies Michigammi, and farther north the copper region is around Houghton, Hancock, and Ontonagon. The Minnesota Iron Company made a very remarkable discovery of iron ore in the Gogebic and Iron ranges, which extend from Ontonagon County to Ashland, Wisconsin. South of these ranges, in the Green Bay region, lie the Felch Mountain and Menominee ranges. The former is about forty miles from Escanaba, on a branch of the Northwestern Railway, and was named in honor of Ex-Governor Alpheus Felch, of Michigan, now living in Ann Arbor, who formerly owned the land hereabout. Here are located the Metropolitan, South Side, and other mines, near the neighboring villages of Felch Mountain and Theodore, while beyond them towers Felch Peak. The Menominee Range is on the division line between Wisconsin and Michigan, and is very productive. Here are located the Iron Mountain, Norway, Vulcan, and other mines. The outlet for all these mines is Escanaba, on Lake Michigan, which contains the three largest docks in the world.—*The Graphic, Chicago.*

## HIGH TEMPERATURE THERMOMETER.

Messrs. Baly and Chorley have devised a high temperature thermometer, the novelty of which consists in the replacement of mercury by the singular liquid alloy of potassium and sodium. The boiling point of this alloy lies somewhere in the neighborhood of 700°, and its solidifying point is —8°, so that between these limits the liquid is particularly suitable for thermometric use.

In order not inconveniently to lengthen the thermometer, the graduations are caused to commence at 200°, the bore for this purpose being widened just above the bulb. The space above the alloy is filled with pure nitrogen at such a pressure that when the glass begins to glow, and, therefore, soften, the interior pressure shall be equal to the atmospheric, and thus any tendency to alteration of volume avoided. The alloy exerts a slight action upon the glass at a red heat, causing a browning, but after the first heating during the preparation of the instrument the action ceases, the stained interior surface resisting further action. It is only necessary to heat the bulb and a small portion of the stem, for the coefficient of expansion of the alloy increases with the temperature in such a manner as to compensate for the error due to the portion not heated. The graduations are thus equidistant, and various points in them are determined by immersion of the lower portion of the instrument in the vapor of high boiling substances whose temperatures of ebullition have been well ascertained.

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## GRAFTING FRENCH VINES WITH AMERICAN STOCK.

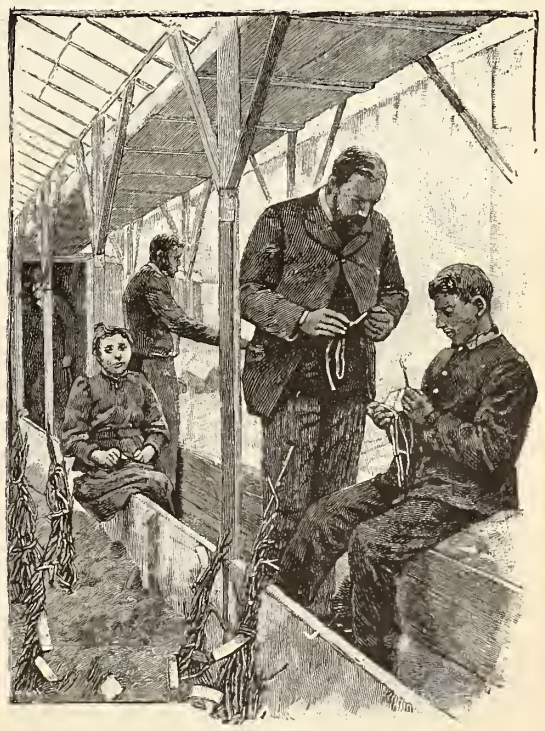
In each hamlet of France white posters affixed to the walls of the town hall make known to the population, in the name of the prefect, the dates in the month of March in which the Professor of Agriculture will give a free course of six days' instruction in grafting the vine near some of the large cities. The heritage of the young viticulturist is an ungrateful earth, vineyards disappearing inch by inch before the dreaded phylloxera, and presses for wine making dropping to pieces for lack of use. They know that the professors for fifteen years have taxed their ability to the utmost in wrestling with the dreaded foe which menaces the vineyards of France with a disaster without parallel, and they know that the disinterested counsels of these learned men are full of wisdom as they give a *resumé* of their experience acquired both by science and practice. The course comprehends the theory of grafting, the practice of grafting, the care to be bestowed in the nursery, the planting of the grafted vines and a visit to the nursery. A diploma is awarded to good scholars.

This course is given in a number of the departments of France, the details of instruction varying somewhat according to the section of the country. Our illustrations and description are taken from the district of Nevers, where the instruction is given by M. Mancheron. Before describing the operations it is necessary to speak of the phylloxera in this district. Though the results of the ravages of the phylloxera are the same, the methods of combating the evil vary. The disaster is spreading. 800, then 1,000, then 2,000 hectares of vineyards, out of 11,000 or 12,000, have almost disappeared. M. Mancheron, with a small annual appropriation, 9,000 francs in all, half paid by the government and half by the department, has undertaken the extraordinary task of creating a departmental nursery, where he directs the culture of the best varieties of the vine on which the new grafts are made. Our first illustration represents these vines strung on poles 6 or 7 meters high, somewhat resembling hop poles. An assistant at the left is cutting the vines near the ground, so as to leave an "eye" in the stump. A large quantity of branches, 6 meters or longer, are thus obtained. The cuttings being too long to transport readily, are cut up into lengths of one meter, just below the bud or eye. The cuttings are bound up in bundles of one hundred and carried to a shed where they are untied and laid horizontally on a bed of sand, which must be absolutely without any vegetation. The sand must also be very dry, as the bud or eye must not have the slightest encouragement to open, as then the success of the graft would be imperiled. If kept dry, the graft can be preserved ten years. The professor attends personally to the instruction of the novices, who consist of apprentices from the primary schools and also of proprietors of a certain age, desirous of being instructed in the operations of grafting themselves in order that they may be able to superintend the work of their men.

CUTTING GRAFTS FROM AMERICAN VINES.

At Nevers an old outhouse, a dependence of the national foundry, is used to store the utensils and for a place in which to give demonstrations. On tables are pulverizers for the insecticide *bouille bordelaise*, on the walls are pails for carbon bisulphide, and around the room are scattered utensils which strike the newcomer with wonderment. The students are given positions which they hold during the course. A blackboard is freely used to assist in explaining obscure points. "Attention!" says the professor, after the manner of a captain. "Take your pruning

STUDENTS CUTTING THE GRAFTS.



DEMONSTRATION OF THE METHOD OF UNITING THE GRAFTS.

shears in your right hand." Forty right hands seize their shears, and, on a second order, forty left hands seize a branch from a pile before proceeding to cut the tendrils. "Cut the tendrils." Forty shears snip the branch. Then the shears are laid aside and the grafting knife is taken up and the sloping splicing cut is given. The operation of cutting and slitting does not require more attention than the joining of the two kinds of vine. This operation requires the professor to give personal instruction to each student. The branch is held immovable by the left hand, the arm being held close to the body to insure the greatest possible resistance. The right must have great agility at this point to perform the delicate operation of uniting the graft. The operations to this point comprise all that the jury, which meets on Saturday, requires to give a student a certificate or diploma that he can make a graft. A good grafter can earn from 4 to 5 francs a day, while the other workers can only obtain 2½ francs. We will now follow the graft in its different operations. M. Mancheron prefers to place the grafts as soon as made. In one method of operating in a greenhouse, where they are ranged in lines in wet sand heated to 30° C., vegetation begins and a month is gained. The graft is gradually prepared to stand the temperature of the outer air, new roots are soon formed and the plants are ready for planting. In the departmental nursery the students are the workers, they being still under the control of the same professor who taught them the rudiments of their art. The students now become real workmen and graft to some purpose. Immense bundles of the American-French vines are sent away; thus good grafted plants with roots are sold at from 5 to 10 centimes without costing the department anything. The new grafts are bringing about a gradual improvement in the vineyards of France. For the cuts and the foregoing information we are indebted to *L'Illustration*. In brief, the French process is to unite a good variety of the French vine with a phylloxera-proof vine, such as the American *raphia*. The graft is made and the two varieties united, after which a root is formed on the American vine, so that the result is the original French grape on an American phylloxera-proof root.

## RECENT INVESTIGATIONS AND IDEAS ON FIXATION OF NITROGEN BY PLANTS.*

By H. MARSHALL WARD.

THREE totally different, though convergent, scientific controversies have arisen during the latter half of the present century concerning the role played in nature by nitrogen, as met with in the air, rain and soil, free or combined, in connection with the ordinary plants of agriculture and forestry; and, quite apart from their real relations to one another, these three controversies have at times been somewhat confused in their issues.

One of these controversies turned on the question of the transformations of combined nitrogen, as met with in the forms of ammonia, nitrites and nitrates, and as organic compounds of nitrogen, resulting from the decomposition of the remains of living beings—plants and animals—in the soil. The outcome has been the proof that oxidations and deoxidations of these compounds are intimately bound up with the physiological activities of living organisms, especially bacteria in the soil; the investigations of Giltay and Aberson, and Winogradsky's brilliant researches especially, have brought what had long been regarded as purely chemical problems into the domain of biology. "Nitrification" and "denitrification," to use the current terms, are phenomena incorporated with those of fermentation, respiration, etc., and therefore involve biological science for their elucidation.

Another of these controversies turned on the question whether the free nitrogen which forms so large a proportion of that huge gaseous ocean, the atmosphere, can be again directly employed by green leaves, and built up as combined nitrogen in plants; or whether, once having been disengaged from organic and other compounds, and passed into the air as gaseous nitrogen, it is forever lost, except in so far as electric discharges and other energetic physical and chemical processes force this relatively inert element into combinations, which the rain then brings down as inorganic salts, and so help to restore the balance of nitrogenous substances in the soil.

This controversy, a long and involved one, started and for some time continued as a peculiarly chemical question, has passed through various phases and branched out into several subsidiary controversies, if we may so term them.

Thus the alleged "fixation" in the soil, especially investigated by Berthelot and Andre, became a scientific question apparently on definite lines of its own, and (so far as any such question can be independent) independent of the question whether ordinary green leafed plants, such as peas, lucerne, wheat, etc., can assimilate the free nitrogen of the atmosphere by processes more or less comparable to those by which they are known to assimilate the carbon they wrench from the carbon dioxide of that gaseous environment.

The latter question, again, became a divided one, chiefly owing to assertions that green leaves could directly assimilate the ammonia, if not the free nitrogen, of the air, and some time was occupied in arriving at the conclusion that ordinary green plants do not directly assimilate or fix either the gaseous ammonia or the free nitrogen of the atmosphere. This conclusion, in opposition to that arrived at by Ville, was regarded as so thoroughly established by the experiments of Boussingault and of Lawes, Gilbert and Pugh, that it has been definitely accepted and taught for many years—and rightly so, from the evidence to hand.

The third of the three controversies referred to at the outset is the more recent one concerned with the question whether certain of the higher green leafed plants, particularly those known as leguminous plants (such as peas, beans, clovers, vetches, lupins, robinia, etc.), when living as they normally do in symbiotic association with certain microscopic and essentially parasitic fungoid organisms which invade their roots, are differently placed from other green plants as regards the power of "fixing" and assimilating the free nitrogen of the atmosphere.

* From *Nature*.

The present position of opinions on this last and most remarkable controversy is the subject of this article, so far as it can be done justice to in the short space at disposal.

It is now well known that leguminous plants are normally found to have certain nodosities or swellings on their roots, and that these swellings are caused by the activity of certain minute organisms which, as the writer of this article first proved, invade the roots from outside, after the manner of a parasitic fungus. The controversy as to the exact nature of these organisms—bacteria, according to Prazmowski, Beyerinck, and others, degraded allies of the Ustilagineæ, or some lower fungus, according to my observations, and the confirmatory evidence of Laurent—in no way affects the truth that these organisms do not kill the plants attacked, or even make them diseased, but incite them to more active life for a time. The evidence on which these organisms (termed "bacteroids") have been taken to be bacteria—their growth in gelatine tubes, staining, and their minute size—is equally in favor of their being lower fungi, and is not sufficiently conclusive. Eventually the nutritious contents of these nodules, with the symbiotic "bacteroids," are absorbed, in whole or in part, by the leguminous plant, and their rich stores of nitrogenous material assimilated by the latter.

The experiments of Hellriegel and Wilfarth, of Lawes and Gilbert, and of others and myself, placed it beyond reasonable doubt that, taking the leguminous plant and its symbiotic organisms together with the pot of soil in which it is grown as a closed system, this system contains more nitrogen at the end of several weeks than can be accounted for by the nitrogen in the soil and the seed at the commencement of the experiment; and this was true in cases where careful precautions were taken to prevent the addition of any nitrogen further than the free nitrogen of the air. The only legitimate conclusion was that somewhere, and somehow, the system fixes free nitrogen from the air.

This matter has been since carried further, however, by Laurent and Schloesing, who, by growing various plants in an air-tight apparatus under such perfect control that they could analyze the quantity of nitrogen both in the plant and soil, and in the purified air, showed that the gain of nitrogen in the former during the progress of the experiments is balanced by a corresponding loss in the latter. They further showed that only two kinds of plants could thus "fix" the nitrogen of the air. These are leguminous plants, and certain lower algæ (perhaps mixed with bacteria) or allied forms. This fixation only occurs under certain definite conditions, moreover. The leguminous plants must be infected with the symbiotic "bacteroids," and the algæ must be exposed freely to the air and light in the apparatus, even a thin layer of the sterilized sand employed sufficed to stop the action of the algæ.

Laurent and Schloesing found no fixation in the case of artichoke, oats, tobacco, mustard, cress, or any other plants experimented with; and their experiments, taken as crowning the edifice of evidence accumulated by them and numerous other observers, have been fairly regarded as proving that leguminous plants, at any rate, and perhaps certain lower algæ, do somehow "fix" the free nitrogen of the atmosphere and assimilate it.

Koch and Kossowitsch have recently claimed to confirm the above results of Laurent and Schloesing with algæ, and it should be mentioned that Frank had previously stated that such fixation by lower cryptogams occurs. Unfortunately we are as yet uninformed what species of algæ are exactly concerned here, and no one has cultivated them pure and confirmed the results.

It will be noticed that, so far, all that is established is that the infected leguminous plants and the algæ of sorts *plus* the known soil (usually sterilized sand to which known additions are made), somewhere and somehow gain in nitrogen at the expense of the free nitrogen of the atmosphere.

Now come the other aspects of the controversy, which is raging chiefly around the question as to exactly where and how this gaseous nitrogen is fixed.

Obviously several possibilities could be suggested.

(1) The gaseous nitrogen could be conceived as directly fixed by the plant which gains in nitrogen—as absorbed by the protoplasm of the living cells exposed to the air—*e. g.*, the cells of the leaves of the leguminous plant, or those of the algæ on the surface of the soil. This view is actively maintained by Frank and a few supporters, who go as far as is possible in this direction, and really again raise the old question which originated with De Saussure, and was rightly regarded as refuted by Boussingault and Lawes and Gilbert.

(2) The gaseous nitrogen could be conceived to be fixed in the soil by means of bacteria or lower algæ (we have seen these are left indefinite), and, when it has been converted into nitrogenous compounds of some kind in the soil, eventually absorbed by the roots of the leguminous or other higher green plant in the ordinary course of events. The principal champion of this view is Berthelot, who claims to have proved that certain soil bacteria, and also the organisms of the leguminous root nodules, have the power of fixing the free nitrogen of the air, and so enriching the soil in nitrogenous compounds. In this connection, of course, the whole question of nitrification and denitrification in the soil will no doubt be involved with the question of the fixation of free nitrogen from the atmosphere.

(3) The fixation of the atmospheric nitrogen could be conceived of as a powerful act of the machinery of the leguminous plant, urged to the necessary expenditure of energy by the stimulating action of the symbiotic organism in its roots. This view, held especially by Hellriegel, Prazmowski, and others, is also shared by Frank, who believes that it is only in their being thus stimulated to greater activity that the leguminosæ differ from many other plants, which, he says, also fix the atmospheric nitrogen directly, but to so much less an extent that the experimental proof of their power to do it is far more difficult.

(4) Another possible view is that the root organisms act merely as accumulators of nitrogenous material, which has been derived from atmospheric nitrogen fixed and combined in the soil, by physical or chemical processes, or in the open ground by the action of soil organisms; and the leguminous plant benefits by devouring (if we may employ this word) the bacteroids eventually, and profiting by their stores of nitrogenous material.

Let us now take these four possibilities in order, and examine them a little more in detail.

The first view rests almost entirely on the statements of Frank, of Berlin, who brings forward a number of experiments which in his opinion show that many higher plants, in addition to the leguminosæ, are capable of directly assimilating the free nitrogen of the atmosphere. For instance, Frank gives results showing that oats, buckbeans, spurrey, turnips, mustard, potatoes, and Norway maple are all capable of fixing atmospheric nitrogen.

Most of Frank's experiments were made in the open air, the pots of plants being simply sheltered from rain; but in some cases, he affirms that he got positive increase of nitrogen with mustard plants under bell jars, properly shut off from the outer air, and through which purified air was drawn.

Apart from these latter, and in spite of Frank's assertion that the quantities of combined nitrogen in the air are so immeasurably small that they may be neglected, it seems fair to object that, in the present state of science, we cannot trust experiments in the open air to decide such a point; while with regard to the experiments with mustard, it must not be forgotten that not only the old results of Boussingault and Lawes and Gilbert are entirely and emphatically opposed to them, but the exceedingly careful recent experiments of Schloesing and Laurent, made with all modern appliances and methods, showed the contrary—no signs of fixation of nitrogen could be obtained in oats tobacco, cress, mustard, cabbage, spurrey, and potato, the very plants Frank used.

Frank replies that completely normal plants cannot be grown under such closely covered glass vessels as these experimenters use, but he accepts their positive results in all cases. Frank's contention is that the plant must be very vigorous, and near its maturing point, before it has power to energetically seize and "fix" the atmospheric nitrogen; but (without denying that it is possible that the utmost vigor may not be as yet attainable under the conditions necessary for culture in closed glass receptacles of limited capacity) it is impossible to overlook the danger that in experiments in the open air, the time which must necessarily elapse before Frank's critical period of maturity on the part of the plant is reached is long enough for all sorts of disturbing influences to come in, especially if any kind of "fixation" in the soil, such as Berthelot asserts, really occurs; the root hairs would take up, and the plant absorb nitrogenous bodies as fast as they were formed in the soil around them, while there would be ample time for the development of many generations of micro-organisms in the medium.

In view of the tenacity with which the belief in a direct absorption of atmospheric nitrogen is cherished by many foresters and agriculturists, it seems imperative that critical experiments should be persevered in; as matters stand, we cannot accept Frank's position as proved, or even as rendered probable.

The possibility mentioned above as an explanation of the danger of accepting Frank's results would be rendered a certainty if the recent researches of Laurent and Schloesing, Koch and Kossowitsch, and Berthelot, in part supporting earlier statements by Frank himself, turn out to have been properly interpreted.

Laurent and Schloesing—and their results are confirmed by Koch and Kossowitsch—declare that sterilized sand, devoid of nitrogenous material, when covered with a growth of certain green and blue-green algæ, probably mixed, however, really does "fix" the atmospheric nitrogen, and gains in nitrogen compounds, but only if the algal growth is freely exposed to the atmosphere in the closed chambers employed. These statements confirm earlier, but less definite, experimental results by Frank; and the latter has recently expressly stated that certain fungi—*e. g. Penicillium cladosporioides*—can flourish in a medium to which no nitrogen but that of the atmosphere has access.

Berthelot goes further, and claims to have established that several species of soil bacteria and fungi, including the fungoid organism of the leguminous tubercles cultivated separately, can "fix" free nitrogen; and if the analyses of the small quantites of materials in his flasks survive the criticism of the chemists, it seems difficult to refuse credence to the views he puts forward; but, as in most of these cases, it is the enormous difficulties of analyses which lie at the root of the matter.

Moreover, different observers differ considerably on this question. Beyerinck, while regarding it as probable that the nodule organisms "fix" atmospheric nitrogen, admits that he does not prove it; and in Laurent's special investigation into this question, he left it also uncertain; while Immendorf failed to satisfy himself that these organisms can flourish without organic compounds of nitrogen; and Frank insists that they do not thrive at all without organic nitrogenous food materials. Moreover, it must not be overlooked that other observers, *e. g.*, Gautier and Drouin, have given evidence pointing to possible phenomena of "fixation" of nitrogen by compounds of iron and other substances clinging to particles of the sand employed, which may interfere with the accuracy of conclusions drawn from experiments where sterilized soil in the open air is concerned.

When we reflect how very minute these organisms are, and what excessively small quantities of nitrogen they need for their life purposes, we cannot be surprised at the difficulties met with in these investigations. But, however far from proved we may regard the question of fixation of free nitrogen by soil organisms, it is perfectly clear that here is a most pressing question for further experimental research, and agricultural and forest practice are alike keenly interested in having the question definitely answered.

The third possible view—that the leguminosæ are able to force free nitrogen into combination with other elements, owing to the energetic action of their protoplasmic machinery stimulated by the symbiotic fungoid organism—deserves more consideration than may at first sight appear, especially to those who are not familiarized with the remarkable phenomena of symbiosis generally.

In the first place, the fact that leguminous plants amply provided with the root nodules *do* "fix" the atmospheric nitrogen, under conditions in which the same plants devoid of the nodules fail to increase their supplies of nitrogen, is far better established than any of the other cases discussed, and must now be accepted

as proved by the experiments of Frank, Hellriegel, myself, Lawes and Gilbert, and especially by the recent splendid investigations of Laurent and Schloesing.

It is true that Frank says the symbiosis is not absolutely necessary for the fixation to proceed, but even he declares that the leguminosæ are stimulated to greater powers of nitrogen fixation by the nodule organisms.

A curious and significant confirmation of the symbiosis theory comes from the experiments of Nobbe, Schmid, Hiltner, and Hotter, who find that *Elæagnus* plants, the roots of which develop nodules due to the invasion of a fungus totally different from the one causing the leguminous nodules, also "fix" and assimilate the free nitrogen of the atmosphere, as shown by their growing and flourishing much better and more rapidly than *Elæagnus* plants side by side with them, but not infected with the root organism. It will be interesting to see if further research shows similar results with any of the physiologically similar root outgrowths, due to very different fungi, met with in *Taxodium*, *Podocarpus*, *Alnus*, *Juncus*, and many other plants, including some vascular cryptogams.

Now comes the question, in what part of the leguminous plant does the actual "fixation" of the free nitrogen occur? Frank stands practically alone in claiming the leaves to be the organs concerned. Nearly all other observers regard the roots as the region, and the nodules themselves as the actual seat of fixation.

Kossowitsch has even attempted the heroic task of deciding between leaves and roots, by inclosing the former or the latter respectively in air-tight receptacles, shut off from the non-inclosed parts, in which gases devoid of nitrogen were circulated. He could not always keep the apparatus perfectly gas-tight, however, and this and other failures met with in these exceedingly difficult experiments undoubtedly weaken the force of his conclusions that it is in the roots and not in the leaves that the process occurs, though it does look as if the balance of evidence obtained fairly supports his conclusion so far as it goes.

There are facts, however, to be gathered from the microscopic analyses of the root nodules, as furnished by myself and others, which have been in great part overlooked in the discussions on this subject, and which, although not conclusive, seem to support the view that the seat of fixation may be in the nodules themselves. For instance, the nodules are supplied with a regular system of conducting vascular bundles, communicating with those of the roots; then their cells, during the period of incubation of the symbiotic organism, are abundantly supplied with starch; further, the cells in which the fungoid organism is vigorously flourishing are evidently exceedingly active, as may be deduced from their large size, brilliant nuclei, protoplasm, and sap vacuole, all of which show signs of intense metabolic activity, lasting for considerable periods. The fact that the sap expressed from these active tissues is alkaline has been interpreted as in accordance with Loew's suggestion that the living protoplasm, in presence of an alkali and free nitrogen, can build up ammonium nitrite, or some similar body. Be this as it may, there can be no question as regards the infected nodule cells being centers where intense physiological activity is going on; and it seems impossible to avoid the conclusion that the vascular supplies from the roots into the nodules bring to these cells water in which various salts, carbo-hydrates, etc., are dissolved, and carry off from them the soluble products of metabolism.

PUTTING THE GRAFTS UNDER COVER.

Presumably these products of metabolism include nitrogenous bodies.

In the ordinary course of events, theory teaches that these nitrogenous bodies—*e. g.*, amides, preceded by simpler compounds—are built up by the machinery of the ordinary living cell protoplasm from carbo-hydrates and nitrates, the energy necessary for the metabolism being derived chiefly (if not entirely) by the oxidation of part of the carbo-hydrates supplied.

This constructive metabolic work of the protoplasm is an act which we cannot explain in detail. We can only dimly perceive that it must be due to some remarkable power the protoplasm possesses—and in virtue of which it is an illimitable machine much more economical in its actions than any apparatus we can construct—of so placing the atoms and molecules of the nitrate, carbo-hydrate, water, etc., with which it works, that they are enabled to undergo movements into which we cannot as yet force them in the laboratory.

The whole matter seems to depend on some peculiar mode of presentment of the atoms and molecules concerned; and we can see no further than that this can be done in the living cell, because the protoplasm is a suitable engine for thus bringing the combining elements into the necessary positions in space.

Now, if this is so, there seems no exclusion of the possibility, at any rate, that the cell machinery may be so stimulated into greater activity that it can even force the notoriously inert nitrogen molecules, properly presented, into combinations with other molecules, resulting in the production of nitrites, amides, or similar bodies in ascending order.

The whole matter no doubt resolves itself into some such question of a properly adapted engine sufficiently supplied with energy. The matter seems capable of explanation, in some degree, if we remember that carbo-hydrates and oxygen are present in abundance; the real difficulty is with the machinery, for we cannot as yet picture the exact construction or working of such an engine as physiology nevertheless impels us to suppose the cell protoplasm must be.

It may be remarked, by the way, that the likeness of the living protoplasm to an engine, in the sense implied, may hold good whether the former is an "emulsion," in the sense of the defenders of that hypothesis, or a "structure," in the sense of those who refuse the emulsion hypothesis.

The fourth of the possible views as to the means by which free nitrogen becomes available to the leguminous plant, however, reminds us that, although the evidence points to the stimulated leguminous plant as the best established example of one capable of doing this work, there are other possibilities.

Berthelot's recent insistance that certain soil bacteria can fix free nitrogen, taken with Frank's, Laurent and Schloesing's, and Koch and Kossowitsch's experiments, make it impossible to deny that the above hypothesis as to the powers of the protoplasmic machinery may apply to the cells of some lower organisms, without symbiosis coming into play at all. The remarkable facts brought to light regarding sulphur bacteria and iron bacteria by Winogradsky, and the still more unexpected results this observer obtained with nitrifying organisms, show that the machinery of the cell can avail itself of sources of energy undreamt of by earlier observers. If, by the oxidation of sulphur or sulphureted hydrogen, or of lower iron compounds, or of ammonia, certain of these organisms can obtain the energy necessary to set going machinery capable of so presenting other molecules of the elements they take up to one another that organic compounds result, it is by no means inconceivable that, at the cost of carbon compounds which they oxidize powerfully, the necessary energy can be obtained to force even free nitrogen into combinations.

It is equally conceivable that in the case of the leguminosæ, the symbiotic organism is really more of a parasite (it is necessarily a parasite in some degree) than is assumed in the third view, and that, at the expense of the carbo-hydrates so richly furnished to it by the host plant, the fungoid organism alone supplies the machinery for forcing the nitrogen into combination, and that when it has stored up relatively large quantities, owing to its activity in the incubators—the root-nodules— provided for it by its host plant, and is diminishing in resisting power, the latter at length turns round and absorbs the stores.

The chief objection to this view is that the gains in total nitrogen seem to be greater than would be thus explained, unless the organisms in the soil outside the roots are also fixing free nitrogen.

Such then, put too shortly as regards the numerous experimental facts, are some of the chief ideas agitating the scientific world on this question, a question which, be it emphatically stated, promises to be of more importance to agriculture in the future than any legislation as to prices, etc., that we can conceive; for if it turns out that the acquisition of free nitrogen by the land, or, what amounts to the same thing, the plants growing on it, can be economically promoted, the farmer and forester may have the control of sources of real wealth not yet dreamt of. Unquestionably there is an enormous amount of careful and very difficult experimental work to be done before we arrive at the solution of the various vital questions raised; but the astounding results obtained during the last decade by a few earnest workers promise brilliant results in the future.

TRANSPLANTING AND TYING UP GRAFTED ROOTS.

## WEST INDIAN LIME.

(*Citrus Medica*, L., var. *acida*, Brandis.)

ONE of the most distinct species of *Citrus* is *C. Medica*, which includes the citron, lemon, and the limes. Of the limes there are sweet and sour limes, characterized, according to Roxburgh, by small pinkish flowers, usually four petals, and a perfectly spherical fruit, having a thin skin of a lively yellow color and pale acid juice. Sir Joseph Hooker states that the word lime is promiscuously applied to fruits very different in character, especially in British India, where the sweet limes of various forms are universally spoken of under that name.

The sour lime, although probably introduced from the East Indies, has made its second home in the West Indies, where, indeed, is its present principal area of systematic cultivation. The history of the sour lime is given by Sir Joseph Hooker in the *Botanical Magazine*, tab. 6,745. It was first described by Rumph (*Hortus Amboinensis* ii., p. 107, tab. 29) in 1750, under the name of *Limonellus*, alias *Limotenuis*, or thin skinned lemon. *C. Limonellus* is also described by Miquel, who says it is cultivated everywhere in the Dutch East Indies. The same plant is well figured by Wight as *C. Limetta*, Risso (*Icones*, t. 958), who says it is wild in the Nilgiris. In the West Indies, McFadyen very clearly describes it as *Citrus Lima*, "a thorny shrub with ovate leaves, pentamerous white flowers, small nearly globose yellow fruit, with thin skin, and an abundance of pure acid juice; it is naturalized in Jamaica, forming strong fences." Brandis (*Forest Flora*, Ind., p. 52) rightly places the sour lime of India as a variety of *Citrus Medica*, L.; other authors refer the sour or West Indian lime to *C. Limetta*, Risso, its nearest European representative, but this latter differs in its sweet juice. The botanical position of the West Indian lime as an acid variety of *Citrus Medica*, L., is now established. This small acid lime seems confined to tropical and sub-tropical zones. It does not appear to flourish in Southern Europe, and as already stated, its present headquarters under cultivation are in the West Indies, where in the islands of Montserrat, Dominica, and Jamaica it is commercially

utilized for the production of lime juice and essential oil.

The lime, as already mentioned, yields juice of a singularly pure, acid flavor. The fresh limes are sometimes exported as gathered, or they are pickled in sea water or brine and shipped to the United States. The demand for the fruit in a fresh or pickled state is said to be very limited. Sir Joseph Hooker states: "The lime is a favorite fruit in the West Indies and the Southern United States, the acid being far more grateful than that of the lemon; and it is, hence, universally used for flavoring soups, etc., and in the preparation of many alcoholic and acidulated drinks. In my younger days it was imported in vast quantities into the city of Glasgow, providing an indispensable material for the brewing of the famous Glasgow punch. That it is now so seldom seen, comparatively, is due to the declension of that social and family intercourse that once was so intimate between the great city and the Spanish Main. It is still (with the lemon) the principal source of citric acid."

Lime juice is obtained by compressing the fresh ripe fruits between heavy rollers. This is exported in the raw state or concentrated. The latter is obtained by evaporating the raw juice in copper or enameled iron pans until it is reduced to about one-eighth or one-tenth of the original bulk. When exported it is a dark, viscid fluid of the consistence of treacle. The concentrated lime juice is not used for food purposes, but devoted entirely to the preparation of citric acid, largely in demand by calico printers. From the rind of the fresh fruits there is obtained by a hand process, called "ecuelling," a fine essence of limes exported in copper vessels. A description, with an account of the mode of using the *ecuelle* (a specimen of which was presented to Kew by Mr. Joseph Sturge, managing director of the Montserrat Company in 1892), is given in the *Kew Bulletin*, 1892, pp. 107, 108. The ecuelle is a copper basin furnished on the inside with numerous prominent studs. The instrument is held in the left hand while the fruit, taken singly, is gently rubbed with a circular motion on the studs. This action bruises the oil glands in the rind and the oil flows in small quantities to the bottom of the basin. The process is a slow one and is performed in the West Indies by women and girls. The task per day is measured in fluid ounces. By distilling the raw lime juice a spirit is obtained known as oil of limes. The essence of limes extracted by hand is far more valuable than the oil of limes. The perfume of the latter is injuriously affected by the heat necessary in distillation.

A recent and somewhat full account of the lime industry at Montserrat and Dominica is given by Mr. Consul Galbraith in the United States Consular Reports, December, 1892, pp. 519–522. As these reports are not easily accessible in this country, the following brief summary is given on points not already touched upon: The area under lime cultivation at Montserrat in 1892 is estimated at "1,200 acres, of which about 900 acres are in fruit-bearing trees." The orchards in Dominica are smaller, and with one or two exceptions, the same care is not exercised in the cultivation of the trees, nor in the manufacture of the juice. "The largest crops are gathered in years in which the rainfall is heaviest. The average yield of fruit from an orchard in full bearing would be about 60 to 80 barrels (an ordinary flour barrel is employed in all orchards to gauge the quantity of fruit) from an acre per annum. . . . . A barrel of fruit will yield from six to seven gallons of juice, and each gallon of sound ripe juice contains from 12 to 15 ounces of citric acid." Raw lime juice is preserved in casks and shipped chiefly to the London market. The manufacture of concentrated lime juice consists in boiling the juice in open pans until reduced to about one-tenth of its volume; "it is then a black, viscid fluid containing from 80 to 100 ounces of citric acid per gallon. . . . Concentrated lime juice is principally shipped to the New York market."

Green limes are exported to a small extent only, and to the English market. Pickled limes, in salt water or brine, are invariably sent to Boston. "The average shipments of products of the lime tree from Montserrat for the last five years were as follows: Raw lime juice, 800 puncheons of 120 gallons each; concentrated lime juice, 200 casks of 54 gallons each; green limes, 1,000 boxes; pickled limes, 300 barrels; essential oil, 2,500 pounds."—*Kew Bulletin.*

## PLANTING AND MANAGEMENT OF TREES.

MR. WILLIAM THOMPSON, of Clovenfords, writes as follows to the *Scotsman*. One of the lessons in arboriculture that the recent gales have taught is that fine picturesque trees, such as are planted either for ornament or shelter round noblemen's and gentlemen's parks, are bound to come to grief when exposed to such gales as we had last winter, unless greater precautions are taken and more skill shown in preparing the ground before they are planted, in the act of planting itself, and their subsequent pruning. Not only do the trees get blown over, but the park walls near which they stand are all torn into gaps by the roots of the trees that have got under them, or else by the trees falling on the walls. As witness what happened last winter at Drummond Castle, near Crieff, where hundreds of very fine oak and other trees were either blown down or so disfigured by the destruction of their branches as to be no longer ornaments. Any one who will carefully diagnose such a case—as the writer has done more than once—will find that a great many of the roots of such trees run along the ground, very near the surface, where the soil most congenial to their extension is situate, in which position their anchorage power, so to speak, is small compared with what it would have been had said roots been for the greater part one to two feet under the surface of the soil. So much for the roots—now for the branches. These are allowed to extend at their pleasure till they form great, long limbs—very picturesque, and much to be desired, no doubt, but very dangerous for their own safety, in the first place, and equally so for the stability of the whole tree. Every one with the slightest knowledge of mechanics knows that the power of the lever increases in the ratio of its distance from the fulcrum, therefore a long branch brings enormously increased power to bear on wrenching the roots of the tree out of the ground, or, if the roots are able to resist, the branch itself has to succumb, in either case destroying the tree for either shelter or ornament. To mitigate, if not completely to avoid, such disastrous consequences, a different system of planting and pruning should be adopted. The foundation of the wall, after the ground has been well drained, should be laid not less than three feet deep, and should be of concrete up to ground level, so that the roots of the trees should not be able to penetrate it. The whole ground in which the trees are to be planted should be trenched at least two feet deep, the good soil of the surface being placed not less than a foot deep, so as to induce the trees to make all their roots at that depth, and not run along the surface, as they do in most cases when planted in the usual way. This weight of soil over the roots would counteract to a large extent the leverage of the long branches. With regard to the branches themselves, they should have their points cut off when they develop a tendency to take a strong lead. Thus the trees would have more compact heads—not, perhaps, so picturesque from an artistic point of view, but still handsome, shapely trees, no three or four branches of which would put such a strain on the roots as one that is allowed to ramble on at its own will would. What I have proposed will, I think, commend itself to the unprejudiced mind as being founded on reason and the known laws that bear on the question; and it is a very serious one, as many within the last quarter of a century have found to their cost.

## RHODODENDRON SCHLIPPENBACHII.*

THIS is a Korean and Manchurian species, with obovate, retuse, undulate leaves, in texture like those of an azalea, produced before or about the same time as the flowers. The young shoots and flower stalks are hairy, the latter intermixed with bracts, most of which fall off as the flowers expand, but of which the inner ones remain. The flowers, as shown in the specimen from which our illustration was taken, are pale rosy-lilac, funnel-shaped, with a broadly expanded five-lobed limb, of which the three upper lobes are marked with dark spots near the base. Stamens ten, unequal in length. It was shown by Messrs. Veitch at the meeting of the Royal Horticultural Society on March 27.—*The Gardeners' Chronicle.*

RHODODENDRON SCHLIPPENBACHII (MAXIMOWICZ)—HARDY SHRUB; FLOWERS PALE ROSY LILAC.

* *Rhododendron Schlippenbachii*, Maximowicz, in *Bull. Acad. Sc. Petersburg*, xv., 276; Rhododendreæ Asiæ orientalis, p. 29 (1870).

## THE DATE PALM.

THE date palm, like the cocoanut, must find a place with the half-dozen trees which are of most value to the human race. It is the type of Phœnix, a small genus of northern Africa, southeastern Africa and tropical Asia. The flower spikes of all the plants of this genus grow from among the long pennate leaves and bear unisexual flowers, the two sexes being produced on different individuals. The flowers have a cup-shaped, three-toothed calyx, a corolla of three petals, their edges valvate in the male and overlapping in the female flower. In the former there are usually six stamens with abbreviated filaments and narrow erect anthers; in the latter there are three distinct ovaries with sessile hooked stigmas. One of the ovaries only develops into a fruit, which is fleshy and one-seeded, that of Phœnix dactylifera being the date.

The date palm is a tree sometimes one hundred to one hundred and twenty feet in height, with a trunk covered with the persistent bases of the leaf stalks and often surrounded at the foot by a dense mass of root suckers. The trees flower in March and April, and as the male trees are generally less numerous than the female, the flowers of the latter are often fertilized artificially. In some parts of India and in Arabia this is done before the flower sheaths expand, an opening being made in the sheath of the female inflorescence, into which a few pieces of the male panicle are inserted. The fruit ripens in the autumn; and through long cultivation a number of varieties, differing in the color, shape, taste and size of the fruit, have been developed in northern Africa and central Arabia, which is supposed to produce the best dates.

The home of this tree is believed to be the whole arid region from the eastern Canary Islands on the west, through the African Sahara, to the lower basin of the Euphrates. The date palm was thought by Brandis to have been introduced into India at the time of the first Mohammedan conquest of Sindh, in the commencement of the eighth century.

The date palm flourishes in the dry regions of northern Africa and western Asia, where it is exposed to excessive heat during the day and not infrequently to frost at night, although it cannot live without a certain amount of moisture in the soil. In Europe it is cultivated in Spain, where it was introduced by the Arabs and where it produces fruit, and on the Riviera, in France and Italy, although it rarely fruits there. In southern Italy, Sicily and Greece, the date palm is now not uncommon, although the climate does not enable it to produce fruit of good quality. On the island of Delos, before Homer's time, date palms sacred to Apollo had been planted; in Syria and Palestine the cultivation of this tree is older than the earliest historical records; and on the southern shores of the Caspian it was also once largely cultivated. It is cultivated and now reproduces itself in Sindh, in the southern Punjab and in the Indian trans-Indus territory. It does not, however, thrive in Bengal, where probably both the heat and rainfall are too great for it.

Not only does the fruit of the date palm supply millions of the human race and their beasts of burden with their chief article of food, but from its leaves the huts of many tribes are entirely constructed. The fiber which surrounds the base of the leaf stalks is manufactured into ropes and coarse cloth, and from the leaf stalks, crates, baskets, brooms and walking sticks are made. The center of the young leaves is eaten as a vegetable, and from the sap, to obtain which, however, the tree must be destroyed, an intoxicating beverage is prepared.

The wood of the date palm is rather light, but is used in house and bridge building, and for various other purposes, although the fruit-bearing trees are so valuable that only the males or trees past the productive age are cut for timber.

The soil and climate of many parts of southern California are well suited to develop the best qualities of this tree, and it is not improbable that the production of dates will soon become an important and profitable California industry.

The date palm was first planted in California nearly a century ago by the Jesuit priests who came into the State from Mexico, and their trees may still be seen in the garden of their mission house at San Diego; and as long ago as 1877 dates raised in California and produced from trees which were only twenty years old were exhibited in San Francisco. An account of the

introduction of the date palm into California, with precise directions for its cultivation and requirements, will be found in the second edition of Wickson's excellent treatise on "California Fruits and How to Grow Them."

The date palm is hardy in some parts of Florida and on the islands of the Georgia coast, and large plants may be seen in the gardens on Cumberland Island, where they have been growing for at least fifty years. The climate, however, of the South Atlantic States is so wet in summer that the date palm will never be cultivated in any part of them except for ornament or as a curiosity.—*Garden and Forest.*

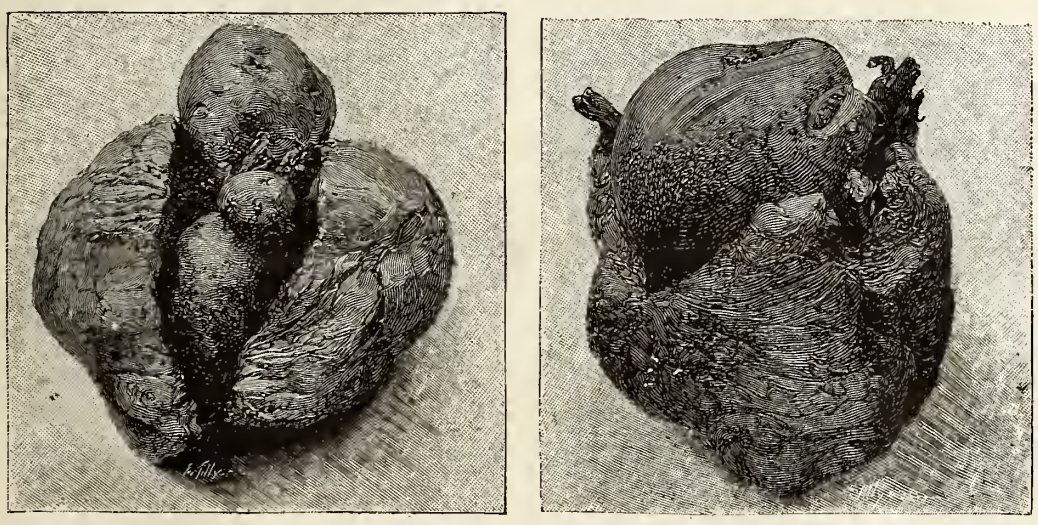
## NEW PROCESS OF PRESERVING POTATOES.

DURING a meeting of the Botanical Society of France, last January, Mr. Prillieux, a professor well known in the botanical and agricultural world, pointed out a teratological fact, with specimens in support of it, that closed the session in an interesting and recreative manner. It was a question of some potatoes that had been treated by an able investigator, Mr. Schribaux, with a view to their preservation, and that exhibited an extraordinary budding (Figs. 1 and 2).

It must be known that in this presentation the physiological side was supported by an experiment whose practical consequences deserve some little attention.

Mr. Schribaux, a professor at the Agricultural Institute, has devoted himself to the work of finding, in the selection of the seeds used in agriculture, a method of fixing new or valuable varieties. The duration of the germinative property of such seeds, and many other studies in this direction, have attracted his attention for a long time back. In a slightly different order of things, he set his wits to work to find a process for preventing stored potatoes from germinating, or "sprouting" as it is commonly called. The only method employed for a long time back has been cutting out the "eyes." It is, as well known, necessary to watch the tubers carefully, since the elongation of their buds renders them unfit for consumption.

So, in cultivation, early varieties of potatoes are sought for spring consumption, on the one hand, and then, on another, late varieties, with a view to having vegetables for winter storage. But such conditions



RICHTER'S IMPERATOR POTATO ACCIDENTALLY BUDDING IN THE INTERIOR OF THE SAME TUBER.

are not always met with at wish, and a certain variety that might be esteemed for its qualities as a vegetable or as food for cattle might soon be excluded from cultivation on account of its vegetating much too soon. Hence the difficulty of coming across varieties of potatoes satisfactory for the table or for cattle. With the new process it will be possible to preserve almost all the known varieties for a long period of time.

If it is a question of a small quantity of potatoes, the buds can be skillfully removed with the aid of a knife, but the cuts do not always cicatrize, and an alteration of the tubers is a frequent result thereof. Now, whatever be the amount of the supply, the Schribaux method will be preferable. The method of procedure is as follows:

The quantity of water judged necessary for the bulk of potatoes to be put into it is poured into a wooden receptacle, say a trough or tub. Such quantity having been determined, there is added to it one per cent. of commercial sulphuric acid, marking 66° B. This porportion of acid suffices for the thin-skinned or kitchen garden varieties, but for those of field culture with a relatively thick skin, one can go as far as two per cent. This is a question of feeling one's way, in which rapid progress is made. The potatoes are left in the acidulated liquid for from ten to twelve hours, and are then washed in ordinary water and spread out in order to allow them to dry.

The tubers thus cleaned are freed from all superficial impurities. The suberose tissue of the skin of the potato protects the interior from the action of the acid, while the tender germs devoid of such tissue are eaten by it. When the eyes of the tubers are cut out by hand, the principal bud is indeed removed, but rarely the small lateral buds, which reappear a short time afterward.

As a consequence of the treatment under consideration, small protective cushions of suberose tissue, curious to observe, form in the place not long before occupied by the germs. We have seen such potatoes, a year and a half after treatment, flabby and wrinkled, but not germinating.

Figs. 1 and 2 represent a peculiar case that is sometimes observed in "Richter's Imperator" potato, and that is spoken of at the beginning of this article. It would be scarcely favorable to the process if it became common, but it is purely accidental.

After treatment, this very prolific variety, although not capable of budding externally, nevertheless preserves enough vitality to bud within if it is kept for a long time, and some of the buds soon become transformed into small potatoes. The old exhausted tuber becomes the mother of an interesting family. Has the fact already been observed? We do not know. However, it is a singular effect caused by the application of the process under consideration, and which renders evident the vegetative power of this variety of potato.

Whatever be the reception in store for Mr. Schribaux's method, it cannot be denied that it is a sensible one, and all those who are interested in the progress of agricultural practice will congratulate themselves on making use of it. In this vast domain, the discoveries that are the smallest in appearance often have economic consequences of great value.—*La Nature.*

## TREE PRUNING.

MORE nonsense has been written on tree pruning and more injury done to woods and plantations by its practice than perhaps any other in the whole range of forest management. Where trees are grown for profit they will, if properly managed, prune themselves, and where for ornament the natural outline is far better than any of the contortions and symmetrical shapes that have been recommended by Brown, Des Cars, and other writers on the subject.

A broken branch may be pruned, a rival leading shoot cut away, or, for good reasons, an ungainly limb amputated, but here all pruning should cease, the practice being wholly wrong and unreasonable, and without one recommendation that could be adduced in its favor. In an economic way the finest plantations of either coniferous or hard-wooded trees in this country are those where the individual specimens are growing so thickly together that the branches are killed outright for fully one-half of their height. Here the stems will be straight and clean, and the timber when converted free from the knots and warping that are so characteristic either of standard specimens or such as have been grown too thinly on the ground.

Every one knows that an oak growing alone or along the margins of a wood is in nine cases out of ten branched almost to the ground, and the bole in consequence rough and ill fitted for any particular constructive purpose, and the same may be said of every other tree, be it hard-wooded or coniferous. Larch and Scotch fir trees growing along the margins of plantations are rough and knotty, and sell at a considerably lower figure when compared with those further in where the branches have been killed back gradually as the trees increased in size.

The same thing is markedly the case in young woods of ash, oak and chestnut, where grown sufficiently thick on the ground to kill off the lower branches, and also to cause the trees to rise straight, clean and tapering. It is a well known fact, too, that the timber of trees so grown is far more elastic and realizes a much higher price than that of the same age, but grown under conditions where pruning might have been a necessity. A case of this kind came under my notice only a short time ago in which one-half of a plantation of hard-wooded trees realized fully one-fourth more than the remaining half. It came about in this way. Both ends and a large patch in the center of the wood had been thinned out severely for the purpose of planting game covert. The trees, standing thinly on the ground, branched out and soon covered the open spaces where underwood had been planted. In thinning the whole plantation the trees on these particular parts were very rough and knotty, and bore no comparison to those where they had been left moderately thick on the ground, and in consequence of which the boles were straight, clean and tapering. This case has special features, inasmuch as the trees over the whole area were growing under exactly similar conditions as to soil, shelter, etc., and were of the same age and species.

Great and irreparable damage has been done to woods and plantations in this country by too heavy thinnings, by commencing the thinning at too early a period, and by adopting the book method of leaving the trees at measured distances apart and a stated number to the acre according to the age of the plantation. Such rules can never be expected to work satisfactorily, the size of trees depending so much on the character of the soil, exposure of the woodland, and other peculiarities of the particular district in which they are planted.

Timely and judicious thinning should never be neglected, but it is the overthinning, whereby branches and knotty trunks are produced and the supposed need for pruning follows, that I wish to deprecate and entirely dissent from. Grow your timber trees so thickly on the ground that the stems are induced to become straight, clean, and branchless for the greater part of their height, and on no account admit sufficient light and air to cause the lower branches to be retained intact, or, in other words, at all times retain an unbroken leaf canopy. The necessity for pruning will then be entirely done away with, and a more valuable class of timber produced. The losses sustained through injudicious planting and the unnecessary and ruinous practice of pruning have taught a lesson that it will be hard to eradicate.—*A. D. Webster, in The Garden.*

[FROM KNOWLEDGE.]

## THE PHŒNICIANS, OR PALM TREE PEOPLE.

By J. H. MITCHINER, F.R.A.S.

THE authorities at the British Museum have recently completed an important rearrangement that must prove of the greatest interest to the student of early civilizations.

Some two thousand years before the Christian era, a branch of the Semitic race, emigrating from the direction of the Persian Gulf, settled on the eastern shores of the Mediterranean Sea. The territory occupied was not large, comprising a coast line of some three hundred miles, with an average width of about fifteen. But if the area was restricted in size, in character it was most diversified—a land of mountain and flood, possessing a Lebanon (white mountain) range, its highest peak rising ten thousand two hundred feet above the level of the sea. Seen from the Mediterranean, the distinctive feature of the landscape was the luxuriant palms that everywhere flourished indigenous to the soil. Hence the old pre-Homeric mariners from the Ægean named the country "Phœnicia," or "the Land of Palms," and to the people who inhabited it they gave the name of "Phœnicians," or "The Palm Tree People." Here on this strip of Syrian shore land, on the slopes of its great southern headland Mount Carmel, on the plains of Samaria and Sharon, and on the banks of the Nahr-el-Litani (Lion River), which rises a short distance from the celebrated ruins of Baalbek, collected and prospered beyond precedent, this remarkable branch of the Semitic race.

In character, instincts, and prevailing habits the Phœnicians seem to have been the very opposite of the militant Semitic of ancient history, as the belligerent Babylonian, the cruel Assyrian, or that "bitter and hasty nation" the Chaldæns.* Instead of prosecuting wars of conquest and aggression, they were essentially an industrious and peaceable people, everywhere pioneers of civilization, whose whole genius and energy seemed absorbed in commercial activity. Ships, colonies, and commerce formed the ultimate aim of their political constitution, and their cities, Tyre, Sidon, and Aradus, became centers for the business of the then known world. Phœnician colonies multiplied, extending to Spain and Africa. The present city of Cadiz constituted the ancient Gades of Phœnicia, while Carthage, the daughter of Tyre, was founded on the African coast about 800 B. C. The strength of Phœnicia lay in her navy. "Ships of Tarshish" (ancient *Indiamen*) explored the Adriatic, Ægean, and Mediterranean Seas, sailed through the Straits of Gibraltar, and facing the perils of the Atlantic, effected the circumnavigation of Africa.

According to general testimony it is to the Phœnicians that the world is indebted for the invention of the alphabet†; but whether by them derived from the Egyptian hieratic system or from monumental phonetic symbols remains at present a debatable question. M. De Rouge maintains that the primitive form of almost every Semitic letter can be deduced from its normal hieratic prototype. Doubtless the exigencies of increasing commercial intercourse necessitated some simplification of the imperfect and labored ideographic writing in vogue. A figurative method would dispense with the use of a multitude of tedious phonetic signs. Simplicity was the object to be attained, and we may be quite sure that in the construction of the alphabetical system necessity was the mother of its invention. In common with other Semitic alphabets constructed subsequently on the Phœnician model, it consisted of twenty-two letters, all consonants, and it may be said to have furnished the basis of nearly all other alphabets. The Hebrew is more closely allied to the Phœnician than to any other language; it might, indeed, almost be considered as a dialect of the same tongue. Both alphabets contain twenty-two letters, are without vowels, and the writing reads from right to left. In religion the Phœnicians acknowledged a single deity—one Supreme Power—but the names by which he was known varied with the locality of the temples. El (great) Ram or Rimmon (high), Baal (Lord), Moleck (King), and Adonai (My Lord). As Sun God, Baal had temples at Baalbek, Tyre, Tarsus, Carthage, and Ekron.

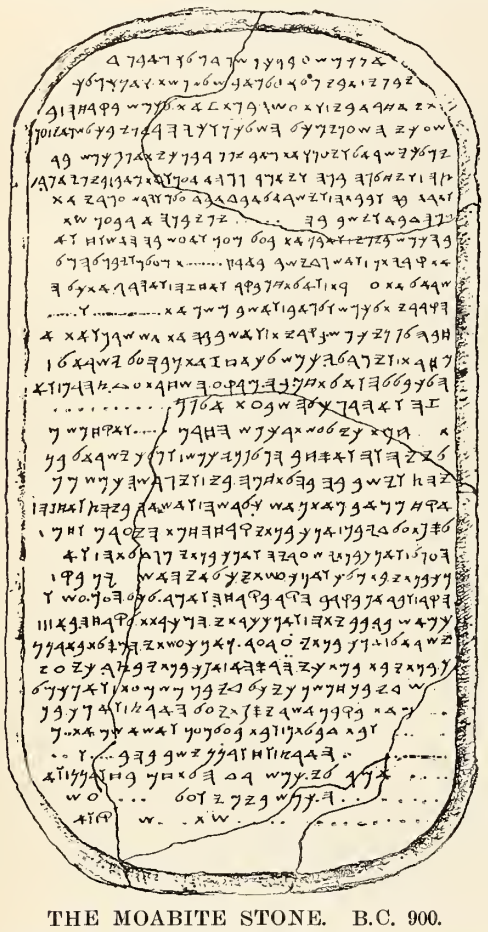
The Phœnician relics in the British Museum—the classification and rearrangement of which has just been completed—occupy three rooms in the northern gallery of the building. The archaic Cyprian sculptures (B. C. 650) are for the most part crude in conception and conventional in execution. The country being destitute of marble, the figures are cut from a calcareous limestone, abounding in holes and fossil shells, quite unfitted for purposes of sculpture. Generally speaking, the bass-reliefs are superior in execution to objects in the round. Most of the faces are depicted with remarkably sharp-pointed noses—a feature even more marked in the terra-cottas. Several heads testify to Assyrian and Egyptian influence; while in the later works (B. C. 150) the results of Hellenistic intercourse are manifest in improved artistic execution.

One of the oldest known alphabetical inscriptions is that of Mesha, King of Moab (B. C. 896), and is known as the Moabite Stone. The original is in the Louvre, but an excellent cast will be found in the second room. The stone was discovered by Mr. Klein, a Prussian, at Diban, a village on the east of the Dead Sea. It is of basalt, rounded at both ends, about three and a half feet in height by two feet in thickness and breadth,

* Habakkuk i. 6.

† Lucan *Pharsalia*, iii., V., 220, 222. Lemormant, i., 84. Herod, V., 58. Diod. Sic., V., 24. Pliny, II. N., V., 12, VII., 56 Tacitus, Ann. XI., 14. Eusebius, Chron. Can.

having on one face thirty four lines of inscription, each line about an inch apart. When first seen by Mr. Klein it was in a most perfect state of preservation, not a single piece being broken off. As soon as open efforts were made to secure the treasure, difficulties with conflicting authorities unfortunately arose. Negotiations for its possession were *not* judiciously managed, and ultimately, rather than surrender the stone to the Turkish government, the Arabs determined to destroy it. They lighted a fire round it, and when sufficiently heated threw on its surface cold water and vinegar, thus causing it to crack and split into fragments. Fortunately a "squeezing" of the inscription had previously been taken by a young *attache* of the French consulate, M. Ganneau. In the woodcut are reproduced the first three lines of the inscription. The words are divided from each other by means of points, and the lines or verses by vertical strokes. The whole inscription gives evidence of great fluency, and of long habituation in the use of written characters. Of the undoubted age and genuineness of this interesting relic of antiquity there can be no reasonable doubt. An article by the Rev. A. Lowry on "The Apocryphal Character of the Moabite Stone" appeared in the *Scottish Review* for April, 1887, but the conclusions of the writer are not accepted by other European Semitic scholars.



THE MOABITE STONE. B.C. 900.

*Analysis of the first three lines.*

ANoKi MeShA. BeN. KaMoShGaD. MeLeK. Mo'AB [He] D—
—IBoNI | 'ABI. MaLaK. 'AL. Mo'AB ShLishiN. ShaT V'ANoKi.
MaLaK—TI. 'AChaIt. 'ABI.

*Translation.*

1. I am Mesha, son of Kamoshgad, King of Moab, the D—
2. ihonite | My father reigned over Moah thirty years, and I reigned
3. after my father.

The stone was erected by Mesha, King of Moab, to commemorate his successes against Omri, King of Israel, and his descendants. This is the same Mesha whose resistance to the united forces of Jehoram, Jehoshaphat, and the King of Edom is recorded in the third chapter of II. Kings. Omri became King of Israel B. C. 929. The date of the stone would be about thirty-nine years afterward—that is, 890 B. C. The characters of the inscription are Phœnician of the Moabite dialect. The last four lines are undecipherable. There is great similarity between the Moabite and ancient Hebrew writing, which sufficiently explains how it is that in all biblical references to communications between these people there is no reference on any occasion to an interpreter.

In June, 1880, an important discovery was made in Jerusalem, in the ancient conduit which conveys the water through the hill and under the Mosque of Omar to the Pool of Siloam. The length of the tunnel is one thousand seven hundred and eight feet (five hundred and sixty-nine yards). It is not straight; the passage winds considerably, and reveals several *culs de sac*, showing that the engineering was defective. The inscription (of which a cast will be found in the second room in the British Museum) was found in a niche in the wall, about nineteen feet from the mouth of the tunnel where it opens into the Pool of Siloam. A spot, twenty-seven inches by twenty-six, had been prepared in the solid wall on the right hand side of the tunnel as one enters from the pool, and made smooth to receive the inscription. Being below the water line, before it could be copied it became necessary to lower the water in the conduit.

According to Prof. Sayce, some of the characters, as *waw*, *zayin*, and *Zsadhe*, are more archaic in shape than the corresponding letters in the Moabite inscription. He therefore regards the tunnel inscription as older than the Moabite Stone, and assigns it to the age of Solomon. It is, however, more generally held to date from about 750 B. C., the time of Hezekiah.

We have here the experience in constructing the Mont Cenis tunnel anticipated by two thousand six

hundred years. It is clear the tunnel to the Siloam Pool was commenced simultaneously from both ends; that in consequence of imperfect engineering skill the workmen nearly missed meeting in the center and overlapped, but, directed by the sound of the picks, altered their course until they joined, and the water flowed throughout the conduit. As might be expected from the difficulty in determining many of the half obliterated letters, the translation given by Canon Taylor differs somewhat from that of Prof. Sayce, but the general meaning is in no way affected thereby.

An object of considerable interest in the third room is the large bronze lion weight, of some twenty manehs, engraved with the inscription in Phœnician characters: "Verified in presence of the supervisors of the silver." In the Babylonian room, close by, are several of these weights, evidently of Phœnician manufacture, of from one to ten manehs each. These were found in Babylonia, and are stamped with the official stamp in both Phœnician and cuneiform characters, and were probably cast exclusively for the Babylonian trade. We know the commerce of the Phœnicians was most extensive. They carried on an active export and import trade with Syria, Judea, Egypt, Arabia, Babylonia, Assyria, Mesopotamia, Armenia, Central Asia Minor, Ionia, Cyprus, Hellas, Spain, the Scilly Isles, and the coast of Cornwall. British tin was highly prized, and appears to have secured a monopoly of the markets within Phœnician influence.

There are many other objects and inscriptions also of great interest, as the sarcophagus of the King of Sidon, B. C. 350, the ancient Coptic, Himyritic, Palmyrene, and Hebrew inscriptions, all of which are admirably arranged, and form a deeply instructive chapter in the book of the past.

## THE SATELLITE OF NEPTUNE.

The planet Neptune is now in the constellation Taurus, a little to the northeast of Aldebaran; so the following free translation by *Nature* of a paper on its satellite, read by M. Tisserand to the Societe Astronomique de France in February, and reprinted in the March number of *L'Astronomie*, is of interest at the present time.

Less than a month after Galle discovered Neptune* in the place assigned to it by Le Verrier, Lassell suspected the existence of a small satellite, and confirmed his suspicion in 1847. This body is very faint, being of the fourteenth magnitude, and a large telescope is required in order to see it. According to Pickering's photometric observations, its size is about the same as that of our moon, but it is 12,000 times further removed from us, and hence the light we receive from it is very dim.

It is well known that the satellite is in retrograde motion round Neptune, in the same way as the satellites of Uranus. In this respect these two planets on the borders of the solar system strikingly differ from the others. Comparing Neptune with other planets, it would be expected that he would possess more than one satellite, but though many scrutinies have been made with powerful telescopes, particularly that at Washington, no one has found a new attendant.

Neptune's moon is not troubled by the motions of companion satellites, so it ought to present a movement of great simplicity, rigorously realizing the geometrical movement considered by Kepler. In fact, some astronomers have proposed to use the satellite as a means of testing the uniformity of certain movements in the planetary system. The body would constitute a clock of marvelous precision, and with nothing apparently to put it out of order. Accumulated observations have, however, brought to light a singular fact with regard to the satellite's orbit. Five or six years ago, Mr. Marth pointed out that observations made from 1852 to 1883 showed that the orbit was being slowly displaced in a certain direction, its inclination to the plane of Neptune's orbit during this period of thirty-one years having increased by about five degrees—an amount too great to be ascribed to errors of observation. What is more, the observations made by H. Struve with the great refractor at Pulkova, during the last ten years, confirm this variation, both as regards its direction and amount. This being so, the question arises as to the cause of the disturbance.

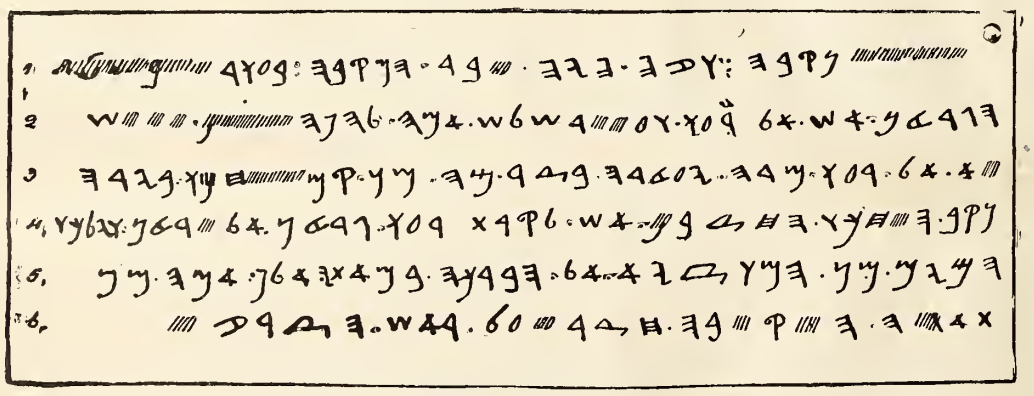
There can be no hesitation in attributing the change to the oblateness of the planet. The amount of polar compression has not yet been determined by direct measurement, and it will doubtless escape detection for some time to come. This is because the disk of Neptune only subtends to us the small angle of about two seconds of arc, and if the oblateness were, say, 1/100, the ellipticity of the disk would be beyond our perception.

But in order to account for the changes established by observation, it is necessary to take other matters into consideration. If the plane of the orbit of the satellite coincided with the equator of the planet, there would be no reason why this coincidence should not be maintained indefinitely. It seems, however, that the two planes are inclined at a certain angle, and it can be demonstrated that in this case the orbital plane must be displaced with respect to the equatorial one, while the angle between the two remains constant.

If the poles of these two planes are supposed to be projected upon the celestial sphere, the former will move uniformly round the latter in a circle, and by the accumulation of observations for two or three centuries, the position of this circle could be very accurately determined. The center of the circle would be above the north pole of the planet; so by this means it becomes possible to determine the direction of the polar axis—a datum which, as we have seen, cannot be determined directly. The facts at present at the disposal of astronomers are insufficient for the purpose of doing this. It appears probable, however, that the angle referred to is from twenty to twenty-five degrees, and the oblateness less than 1/100. Prof. Newcomb, without going into detailed calculations, has assigned the same cause to the phenomenon.

The fifth satellite of Jupiter, discovered by Prof. Barnard in 1893, ought to exhibit a similar change to that undergone by Neptune's attendant. It does not appear that the four larger Jovian satellites are able to disturb the new one in an appreciable manner; in this case, moreover, the large oblateness of Jupiter must be taken into consideration. But the oblateness produces another effect. It may not modify the position of the orbit of the satellite, because this small body revolves in the plane of the planet's equator, but it may cause the orbit to turn in its plane, and calculations show that it ought to produce a complete turn in about five months. If, therefore, this orbit is not exactly circular, but ever so little eccentric, a time must come when the satellite must appear at a greater distance from the east than from the west limb of the planet, and this is what Prof. Barnard has actually observed. But seventy-five days after these distances must be reversed, for the greater distance should then be from the west limb. It is to be hoped that future observations will decide this point. The effect referred to ought also to be shown by the satellite of Neptune, though it is much less pronounced than the change of the orbital plane; nevertheless, its determination will not be long delayed.

* Neptune was looked for and found by Galle on September 23, 1846; the satellite was discovered by Lassell on October 10 of the same year.



COPY OF INSCRIPTION OF SILOAM.

*Translation.*

1. *Behold the* excavation! Now this is the history of the tunnel. While the excavators *were using*
2. the pick each to his neighbor, and while there were yet three cubics *to be excavated* the voice of one call-
3. ed to his neighbor, for there was *an excess* in the rock on the right. They arose . . . they struck on the west of the
4. excavation, the excavators struck each to meet his neighbor, pick to pick, and there flowed
5. the waters from the outlet to the Pool for the distance of 1,000 cubits, and . . .
6. of a cubit was the height of the rock at the head of the excavation here.

## EXTINCT MONSTERS.*

A BRIEF ACCOUNT OF SOME OF THE MOST REMARKABLE FORMS OF ANIMAL LIFE IN THE PAST HISTORY OF THE EARTH.

By STEPHEN BOWERS, A.M., Ph.D., editor of the *Fallbrook Observer*, Fellow of the Geological Society of America, Corresponding Member of the Geographic Society, Philadelphia Academy of Sciences, Member of the Philosophical Society of Great Britain, etc.

THE history of life on this planet previous to the advent of man, which is found recorded in Nature's great stone book, reads more like Oriental fable than like unvarnished truth. The explorations of the geologist have brought to light an ancient fauna that in many respects excels the most feverish human imagination. Their remains have doubtless given rise to stories told in early days of giants, dragons and other monsters. But unlike those fables the intelligent savant has been able to construct a faithful history of the huge animals that walked upon the land, waded in marshes, swam in early seas or navigated the air, but now lie inhumed in the rocks sleeping the sleep of ages. Among reptiles our own North America excels all other lands in singular forms, which also applies to mammals. In presenting a series of articles on the history of extinct monsters, we hope to awaken an interest in the

* From the author's pamphlet.

minds of the young that will lead to the study of forms long since passed, upon which was employed the pencil of divine skill, for each filled a place in the economy of the Creator as important as that of more modern forms. In their study we must consider their environment, as the surrounding fauna; also the flora, the condition of the water, air, climate, etc., and we shall find the same adaptability that is apparent in animals of the present day. Technical terms will be avoided as far as possible, except the names scientists have given to forms we shall describe, with which all students of geology should be familiar.

### SEA SCORPIONS.

There lived in early seas somewhat singular creatures known as sea scorpions. They possessed a coat or armor and had jointed bodies supplied with legs for crawling, swimming and seizing their prey. They belonged to the crustaceans and were lobster-like in form, though unlike, in some particulars, any creature now living. In the division of animals they would be classed with articulates as crabs, lobsters, centipedes, spiders and insects. The bodies of these sea scorpions were divided into rings or joints, each fitting nicely into each other and forming a complete armor. The celebrated Hugh Miller was the first to discover them in certain parts of the old red sandstone, which through his subsequent explorations yielded so many hidden secrets. The workmen called the remains "seraphims," because of the many markings on the hard coat of its jointed armor, which suggested to their untutored minds the idea of feathers and wings. Their resemblance to land scorpions was so close that but from the fact that they breathed water instead of air they would be removed out of the crustacean class. Their tails were powerful and the head or front part of the body was covered with a carapace which, with their size, reaching nearly six feet in length, made them dangerous prey in early times. They had compound eyes made up of small lenses which enabled them to see distinctly. These curious animals were what is known as "jawfooted," and used their limbs for walking, seizing their prey and for eating. They are believed to have been rapacious in their habits, and possibly acted as scavengers in the early seas. They were numerous in the Silurian seas, but entirely disappeared in the Carboniferous age.

### EARLY SEA ROVERS.

In the Lower Silurian age a remarkable cephalopod made its appearance in great numbers and variety, but entirely disappeared in the Jurassic period. We refer to the Orthoceratite, which derives its name from a Greek word signifying straight horn. The animal lived in a straight or conical shell, divided into a great many chambers through which ran a siphuncle or tube. Some of these attained a length of between thirty and forty feet. The animal was something like a squid, and had long muscular arms with which it seized and overcame its prey.

The siphuncle or tube traversing the septa of the shell doubtless enabled the animal to inflate the chambers of its ponderous house with air, by which means it could easily rise to the surface of the water, the expulsion of which enabled it to rapidly sink to the bottom again. They were probably the sea rovers of the early seas and occupied the place of fishes. Their unwieldy shells, however, must have impeded their progress, except when traveling in a straight line. Hundreds of species are found, some not larger than a lead pencil. Owing to the hard shell in which the animal was incased their forms are preserved, and in a petrified state some of the larger weigh hundreds of pounds. Could the reader stand one of these on end it would reach to the eaves of an ordinary three-story house.

### THE GREAT FISH LIZARDS.

Formidable as the sea scorpions which we have described may seem to have been, they were as infants compared with the fish lizards that inhabited the ancient seas. One of them, the Ichthyosaurus, was probably the most rapacious and formidable of all the aquatic monsters. In some respects they resembled whales, yet were not related to them. The Icthyosaurus had two pairs of paddles or fins, but its long tail was its chief organ of propulsion. The fore paddles were composed largely of small bones, forming a sort of bony pavement, and along the backs of some species was a row of bony excrescences. It was doubtless without scales, and covered with a leathery skin. It had no distinct neck, but possessed powerful jaws, which were a marked feature of the monster. Its enormous mouth was filled with more than two hundred teeth inserted in a long groove. Some attained a length of nearly forty feet, and with jaws from four to six feet in length, one can imagine something of its formidable character. A peculiar feature was the eyes, which were exceedingly large, measuring, in some instances, nearly or quite two feet in diameter, and were surrounded by a series of overlapping bony plates. The expanded pupil doubtless admitted much light and gave the reptile great power of vision. The bony plates performed an important office, for not only did they protect the monster's eyes when diving into deep water, but they probably acted the part of a microscope or a telescope at the will of the creature. "By bringing the plates a little nearer and causing them to press gently upon the eyeballs, so as to make the eye more convex, or bulging out, a nearer object could be discerned. And on relaxing the pressure, thus enlarging the aperture of the pupil and diminishing the convexity, a distant object could be focused upon the retina." The Ichthyosaurus fed principally on fishes, as the coprolites or petrified excrement plainly shows. It is evident that they were viviparous or produced their young in a living state, as in whales. It is believed that they were to a certain extent amphibious, and sometimes sought the shores. The bony structure of the fore paddles indicates this, also the fact that a strong inverted bony arch beneath the chest passed from shoulder to shoulder, which would support the monster when on the land. The Ichthyosaurus, which was planned on a different line from any creature, probably, that has ever existed, flourished in the Jurassic period, disappearing in the succeeding age.

### THE GREAT SEA LIZARDS.

Contemporary with the fish lizards were the long-necked sea lizards, which in structure were, if possible, more curious than the former. The Plesiosaurus combined certain characteristics, more or less marked, of several animals, but at the same time it stood out distinct and was related to none. It had the head of a lizard, the teeth of a crocodile, the neck of a swan, the ribs of a chameleon, the paddles of a whale, and the trunk and tail of an ordinary quadruped. It was more distinctly reptilian than the Ichthyosaurus. The teeth were set in distinct sockets as they are in crocodiles. Each pair of ribs are said to have surrounded the body with a complete girdle formed of five pieces, as in the chameleon and iguana, giving it facility for contracting and dilating the lungs. Probably the most remarkable feature of the structure was its neck. It was composed of a greater number of vertebræ than the swan's, which, compared with the remainder of its body, has the longest neck of the feathered race. So of the Plesiosaurus among reptiles or quadrupeds. The unusually long neck would necessarily support a comparatively small head. Its paddles were also unusually long, and must have given it means of rapid propulsion. Owing to its small head and long neck it was probably unable to cope with the fish lizards, hence was compelled to live in lagoons and near the shore. It was also probably able to live on the land a portion of the time, though out of its native element it would present an awkward appearance. The remains of more than twenty species of sea lizards have been found, some of which indicate a monster of forty feet in length. Unlike the fish lizards, the Plesiosaurus had flat or slightly concave vertebræ, which made the backbone less flexible than those of the cup-shaped Icthyosaurus. They appear suddenly in the New Red Sandstone, and disappear as suddenly in the Cretaceous period. It was a marine, air-breathing carnivorous reptile, and was furnished with an apparatus which enabled it to sink to the bottom and rise again at pleasure. As far as known, it was the creation and development of a type that had not previously existed, and that has no successor.

### THE OLD TIME DRAGONS.

After becoming conversant with the forms of the monsters that lived in the early ages of the world, one is not surprised that traditions of hideous dragons have come down to us from the misty past. For several hundred miles along the flanks of the Rocky Mountains lie inhumed the remains of dragon-like forms that prove reality to be sometimes stranger than fiction. We refer to a large family of reptiles known as Dinosaurs. They lived in Mesozoic times, and are found in Europe, Africa, India, Australia, as well as in this country. According to the Vailian theory, the earth at that time was surrounded with rings of aqueous vapor, which overcanopied the globe, producing a uniform or hothouse temperature, which was exceedingly favorable to the development of reptiles. We doubt not that their remains will yet be found in arctic and antarctic lands, among other semi-tropical plants and animals. This was pre-eminently the age of reptiles. In this era they culminated and began their decline.

Dinosaurs were the largest terrestrial and semi-aquatic reptiles yet discovered. Some resembled crocodiles in many respects, and others the bony structure of the ostrich, especially in the pelvis or bony arch connecting the hind legs. Some species being three-toed and walking on their hind legs left tracks which early geologists mistook for huge bird tracks. The body of some species was covered with a horny coat of armor consisting of bony plates and spines. They had four legs, the hinder being very large. Some attained a size rivaling the modern rhinoceros and elephant.

One species of this reptile, known as Brontosaurus, was a vegetable-feeding lizard, about sixty feet long, and must have weighed at least twenty tons. Its small brain and spinal cord indicates a slow-moving reptile. It was amphibious in its habits, and probably fed on aquatic plants and land vegetation. Its tracks cover the space of a square yard. The body was comparatively short, with massive hind legs, and a powerful neck and tail. While the vertebræ were large, yet those of the neck and body had large cavities, connecting with other internal cavities, giving them the appearance of being honeycombed. They combined both strength and lightness, which was necessary in the support of the long neck. But the vertebræ of the enormous tail, which dragged on the ground, was more solid, giving proper balance and equipoise to the other parts.

The thigh bone of a species known as Atlantosaurus, found by Prof. Marsh in the Rocky Mountains, is over six feet long. The reptile attained the enormous length of over eighty feet. It seems to have walked on its hind feet, and must have stood fully thirty feet high. Its legs and ponderous tail formed a tripod when the creature was at rest. The feet were armed with claws, which, if in proportion to its other parts, must have been formidable weapons of defense. The remains upon which it fed have been found with the monster and show that it lived at a time when the Rocky Mountain region was covered with a subtropical vegetation. This is another proof of the Vailian theory or annular system existing in the early ages of the world.

Another large species of Dinosaurs found in the Rocky Mountain region is known as Aptosaurus, a complete skeleton of which was obtained by Prof. Marsh. It was about thirty feet long. Morosaurus, another form, was very numerous. It had a small head and long neck. The vertebræ of the neck were lightened by deep cavities in the centre, as those of birds of flight. This species was about forty feet long and walked on all fours. Diplodacus was another which attained a length of about fifty feet. It had slender jaws, and its teeth were confined to the fore part of the same. Several species of Dinosaurs were found in England prior to their discovery in America. One, Cetiosaurus, attained a length of probably thirty-five feet or more, and was doubtless endowed with great physical strength. In this chapter we have briefly noted some of the herbivorous or vegetable-eating dragons of olden time; in our next we will speak of the carnivorous or flesh-eating dragons, some of which possessed even more strange and weird forms than those we have described.

### CARNIVOROUS AND OTHER DRAGONS.

As previously said, during the Mesozoic era, Dinosaurs and other reptiles spread over a large portion, if not the whole earth. The overcanopying vapors produced an Eden like climate, causing tropical vegetation to flourish from pole to pole. During that period, existing probably for millions of years, there appeared a variety of forms and types of Dinosaurs, as well as other reptiles. In the last chapter we had something to say of the great herbivorous lizards that walked on the land and swam in the seas and lagoons of olden time; but in this chapter we will speak of some of the carnivorous species that appeared at the same time. While many species were smaller than those we have described, yet they were more active. One of them, named Megalosaurus, attained a length of thirty or more feet and walked on its hind feet. It had formidable teeth set in sockets and enormous claws, and was doubtless an active and aggressive creature, somewhat similar in nature to lions and tigers of our day. Some parts of the skeleton show an approach to the ostrich in type. The teeth were long and turned backward in the shape of a pruning knife, and had serrated edges. They produced the combined effect of a knife and a saw cutting with the whole of their concave edges. The larger bones were hollow, combining lightness and strength and enabling the reptile to move with agility. In hopping or leaping it is not unreasonable to believe it had the power to bound at least its own length, which would be from twenty to more than thirty feet. It must have been able to raise its head to a height of fifteen or twenty feet.

Another carnivorous Dinosaur, and very remarkable in some respects, was discovered by Prof. Marsh, and to which he gave the name Ceratosaurus or horned Dinosaur. This great lizard showed certain characteristics not found in others previously discovered. The skull supported a horn, and all of the bones of the pelvis were fused together as in modern birds. The vertebræ also differed from the other Dinosaurs, and it differed externally. Its body was protected as that of crocodiles, with long, bony plates in the skin, especially along the top of the head and neck and along the back. Its head seen from above resembled the crocodile. The teeth of this horned dragon resembled those of the Megalosaur described above. The eyes were protected by protuberances of the skull. The fore limbs were comparatively small, but armed with powerful claws.

The remains of another wonderful Dinosaur discovered on the eastern flank of the Rocky Mountains by Prof. Marsh is known as Stegosaurus or plated lizard. Its bones indicate aquatic life, but it doubtless passed much of its time on the land. It was covered, in some parts at least, with large bony plates and with spines. Some of these sharp spines were more than two feet long and stood in pairs along the tail. Along its back from near the head to the tail there stood up huge, bony plates from two to three feet in diameter. Standing on all fours, the head and tail were near the ground, the body forming an arch from twelve to fifteen feet high. It had a rather small head with large eyes and a single row of teeth which were replaced by others when lost. The fore limbs were short and massive, and pointed with five fingers. The hind legs were much more powerful, and when desirable the reptile could support itself on them and its tail, forming a tripod. The three toes on the hind feet were covered with bony hoofs. The fore limbs could move in any direction like the human arm, and were doubtless used in self-defense. But its most effective weapon was its tail, armed with four pairs of long spines or horns. The most remarkable feature of this strange animal is yet to be noted. It possessed two sets of brains. One was located in the skull and the other in the region of the haunches, formed by the enlargement of the spinal cord, and was ten times larger than the former. This curiously formed lizard attained a length of thirty or forty feet.

Another of the Dinosaurs is known as Iguanodon. It was an enormous reptile, attaining, according to Prof. Owen's estimate, a length of fifty or sixty feet. It was one of the largest of the saurians of the ancient world. Notwithstanding the fact that it had a body larger than the elephant, yet it probably habitually walked on its hind legs. Think of a creature stalking on the land on its hind feet dragging after it a tail twenty or thirty feet long, and with its head sufficiently elevated to gaze into the upper windows of an ordinary four-story house! A large pointed bone grew out from each hand or fore foot forming a kind of huge spur, and was probably used in self-defense, and also in pulling down the foliage of trees upon which it fed. The Iguanodon, of which there were many species, doubtless spent much of its time in the water, using its huge tail as a means of propulsion.

But the most singular of all Dinosaurs is yet to be described. It is called Triceratops. It derives its name from the Greek *treis*, three; *ceros*, horn; *aps*, face. It was one of the last of the Dinosaurs and flourished near the close of the Mesozoic or Reptilian age. It would seem as though nature had exhausted her ingenuity in its curious formation. It had a ponderous head supporting two large horns above each eye and another one over the nose. Its head was seven or eight feet long. The back part of the skull arose into a kind of a huge crest, and was protected by a fringe of heavy plates. The teeth were remarkable in having two distinct roots, and the mouth formed a kind of beak sheathed in horn similar to turtles. This great lizard was covered in part or in whole with bony plates and spines. The fore feet were larger than in most Dinosaurs and it evidently walked on all fours. It was about twenty-five feet long and had the smallest brain in proportion to the skull of all known vertebrates. Prof. Marsh says that the head of this strange creature must have increased in size generation after generation in order to bear its armor of bony plates which was finally the cause of its extinction. In the course of evolution its head became too heavy for its body, and it literally died of "big head." The remains of this reptile are found in what is known as the Laramie beds, which are of fresh water or brackish water origin, extending some 800 miles along the eastern flank of the Rocky Mountains. With these are found the fossil remains of other Dinosaurs, Plesiosaurs, crocodiles, turtles, and other reptiles, birds, fishes, and mammals.

The remains of many other species of Dinosaurs have been found of which our limited space will not permit us to speak, but for a description of which we

must refer the reader to the works of Marsh, Hutchinson and others. Our next chapter will be devoted to flying dragons.

(*To be continued.*)

## SOME RARE BIRDS.

We publish to-day an engraving—for which we are indebted to our honored contemporary, the *Illustrirte Zeitung*—of some of the rare birds that were exhibited in Berlin last year by the Ornis, an ornithological society. Very high prices were set on some of these little birds. The pair of little green, flat-tailed parrots were valued at $240, because they are so rare, even in their native country (Australia), that live specimens of them have never before been seen in Europe, and stuffed specimens are seldom found in the natural history museums. The green, flat-tailed parrot was represented among many other ornithological curiosities in Hagenbeck's collection at the Chicago Exposition. For the amateur collector the small-beaked parrot with fiery red under-wings, from South America, is especially attractive because it is so tame and droll. Another bird that never before reached Europe alive was the South American yellow-hooded oriole. Other specimens which were very pleasing on account of their beauty, although not quite so rare, were the little humming bird, the organist of Brazil, the Indian dove, the two finches, one from America and the other from Africa, and the dwarf owl from Mexico, and finally the little European bird known as the Alpine wall climber.

EXHIBIT OF RARE BIRDS.

1. Mocking bird. 2. Song thrush. 3. Thrush. 4. Alpine wall climber. 5. Magellan's finch. 6. Finch. 7. Mexican dwarf screech owl. 8. Oriole. 9. Organist bird. 10. Humming bird. 11. Spring fruit dove. 12, 13, 14. Parrots.

## THE DURFORT ELEPHANT.

MR. ALBERT GAUDRY has written a memoir upon the Durfort elephant for the volume published by the professors of the museum on the occasion of the centenary of this establishment. It is somewhat curious that the most imposing specimen of the rich paleontological collection under Mr. Gaudry's care, although very well known to the scientific world and to the public at large, had never before been the subject of a special work. Our readers know from the articles of the lamented Dr. Fisher how the skeleton of the gigantic proboscidian was discovered, and with what skill it was extracted from its repository, and they are not ignorant of the fact that science is indebted to Mr. Cazalis de Fondouer for this beautiful piece.

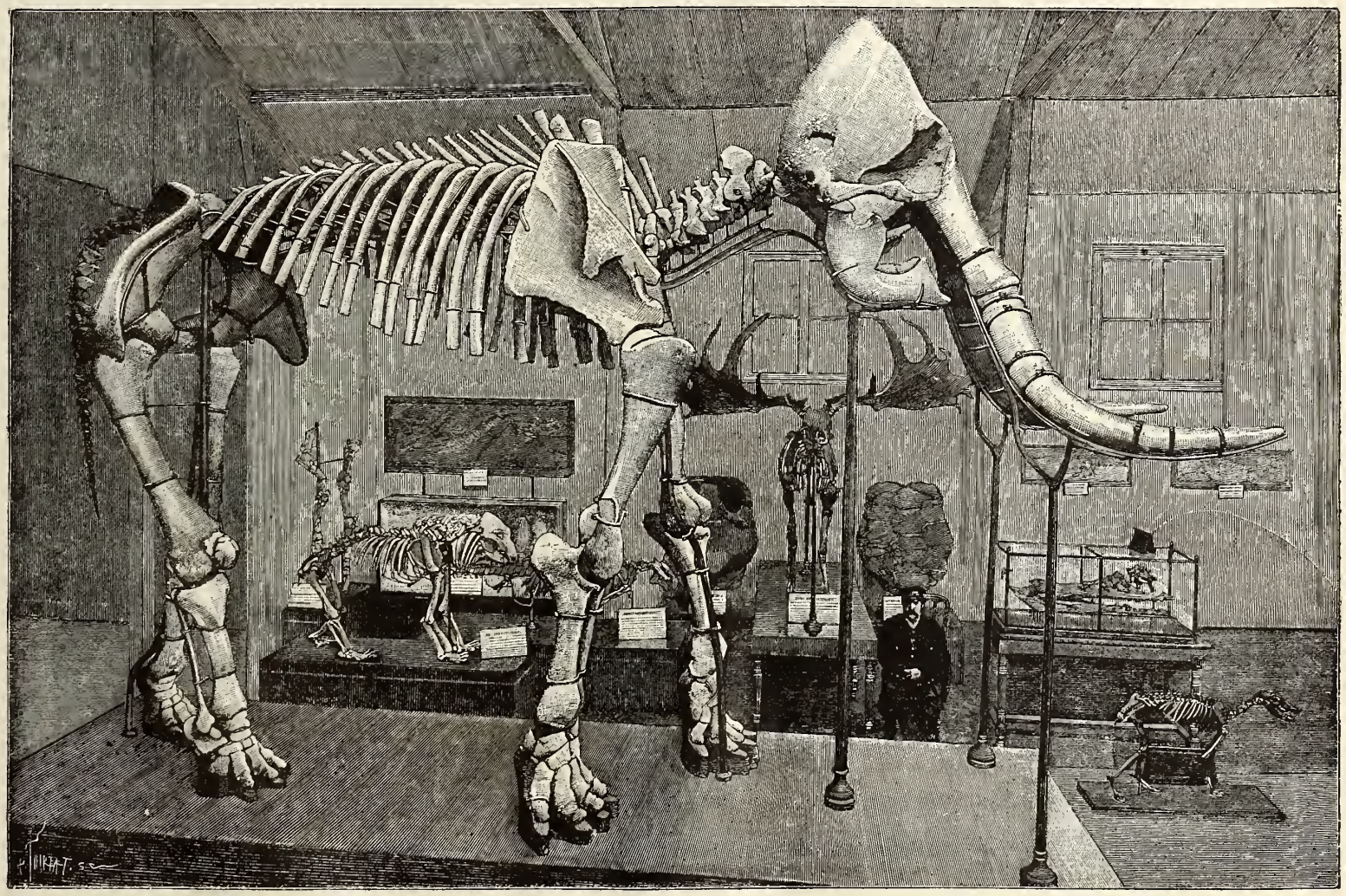
Mr. Gaudry, in his memoir, discusses the name that it is proper to give the Durfort elephant. He shows how delicate a matter the specific determination of fossil elephants is, on account of the numerous transitions that connect all the forms. The Durfort animal, which is from the Pliocene, must be referred to the *Elephas meridionalis*, not to the primitive type of this species, but to a breed already modified that begins to approach the quaternary elephants.

Along with the skeleton of the elephant there has been found at Durfort a large number of bones belongs ing to various genera of animals—hippopotamuses, bisons, deer, a rhinoceros and a horse. All these animals must have perished in the mud of a small marsh of the Pliocene epoch, since the majority of the bones have been found with their anatomical connections.

There have also been found in the same deposit a batrachian of the size of a large common toad, some remains of a pike and various shells of mollusks. A study of vegetable impressions made by Messrs. Saporta and Marion permits of restoring the landscape in which the Durfort elephant moved. Forests of various oaks, among which *Quercus Lusitanica* was pre-eminent, extended around the Durfort pond. There were also some beeches and some arborescent species that have representatives at present on the Caucasus or in Persia, such as *Planera Ungeri* and a *Parrotia*.

Mr. Gaudry terminates his memoir with some interesting remarks upon the dimensions of terrestrial animals during geologic times and with some philosophical considerations upon the disappearance of these giants of past epochs. According to the eminent professor, the reign of brute force took place during secondary times, while the dinosaurians, which were the most gigantic of all the continental quadrupeds, and doubtless the most stupid, were living. The real apogee of the animal world, comprising the handsomest, most active and most intelligent quadrupeds, shows itself at the end of Tertiary time, during the Miocene and Pliocene epochs, that is to say, immediately before the reign of man.

Mr. Gaudry's memoir is accompanied with a superb phototype from which the accompanying engraving was made.—*La Nature.*



SKELETON OF THE GREAT FOSSIL ELEPHANT OF DURFORT, AT THE PARIS MUSEUM OF NATURAL HISTORY.

## AN INTERNATIONAL LANGUAGE.

AT a recent meeting of the New York Academy of Science, Dr. Achilles Rose read the paper. The desirability of having a single international language must have impressed itself upon the minds of all who had attended an international medical congress. Very few of the members at such meetings were able to speak, or even to understand, more than two languages, perhaps only their own, whereas three had been official, and at the next meeting five would be recognized. The advantages to be derived from a single official language had occupied the minds of many thinkers. The best known of later attempts to invent a language was that of Volapuk, but the impracticability of this as a language of science had been conceded by those who had given the matter special attention. The rivalry of nations was against the acceptance of any of the three great living languages—German, French and English—as official, not to mention other objections, particularly their want of richness in combinations. On the other hand, Greek was free from these objections and possessed many positive advantages. True, it was called a dead language, but it was dead only in the minds of college professors. It was spoken to-day by several million people essentially as it was in the times when the classics were composed. Medical terminology and that of the arts and sciences in general were already dominated by the Greek language. It was particularly rich in combinations and was the most beautiful language spoken, its innate superiority accounting for its survival of centuries when the Greeks themselves had suffered all kinds of reverses and been reduced to a handful in numbers. The author estimated the number of those speaking the Greek language to-day at seven millions. Latin, on the other hand, was not a living spoken language, and was kept in existence only through philological and theological literature.

The conversational language of a nation was the ke y to its written language, and the easiest and best way, the most efficient way, was to begin with the language as the people were accustomed to use it in everyday life. According to the present methods of teaching Greek, it would be considered too difficult to learn, and could never become an international language. But this would be true of any language whatever if it were taught as Greek and Latin were taught in our colleges. There was no truth in the statement that the Greek of to-day was dominated by the Slavonic or Turkish; nearly everything of foreign origin had been excluded. Specimens of magazines and letter-writing in Greek were exhibited.

The author criticised severely the collegiate method of teaching Greek, which he said originated in 1528, with Erasmus, a crank in this matter. How difficult it would be to gain a knowledge of English hy pursuing the same course, starting, for instance, with the poems of Longfellow, parsing every sentence and pronouncing the words as it might suit the fancy of the teacher! To learn a language one should begin with easy books, children's books, and listen to the conversation of natives. By such a method one would soon be enabled to do away with the dictionary, which at present even scholars required in reading Greek.

A language which gave terms to all new inventions and discoveries, and which could not be replaced by any other, was already, to a certain extent, an international language.

Dr. W. H. Thomson thought the question naturally assumed two forms: 1. Was an international language at all practicable at a medical congress? 2. If it was, what language should be selected? Regarding the first question he saw no possibility of establishing an international language for medicine or science unless a revolution were effected in our systems of education and there was co-operation among the different educators of the world in bringing about so desirable an end. The law of the evolution of language made it imperative, if such a result was to be accomplished, that the language be learned in such a way that men could think in it.

*Afferent and Efferent Language.*—Physiologically considered, all language was afferent and efferent. Afferent language came through the eye and ear; efferent language passed out through the organs of speech or in the handwriting. Afferent language was acquired chiefly through the ear, and it was only later in life that we used the eye in reading and writing. Yet the colleges would have us learn Latin and Greek exclusively through the eye, which had the least developed tract connecting it with the centers for expression. Dr. Thomson could speak very feelingly upon this subject, for he had studied Greek under his preceptors diligently for many years, and had translated a number of the classics, yet he had never found it possible to think in that language.

He was then set to studying Arabic in the same manner—*i. e.*, by the eye alone—but he soon became convinced that he could never get a practical use of it in that manner, and abandoned the method, and went to live among the Arabs themselves, with the result that, notwithstanding the difficulties besetting that copious language, he could yet, after the lapse of twenty-five years, express himself in it with facility. The same difficulties encountered by himself in the study of Greek and Latin were being encountered to-day by his sons at Harvard, where they continued, as in other colleges, to teach those languages by sight instead of by sound and conversation. German and French were taught at Harvard in the same manner; a fact which had always made him sorry for young men who had to acquire their knowledge of the languages at that institution.

Supposing it possible to introduce an international language for medicine, he agreed with Dr. Rose that Greek was best. He would unhesitatingly choose Greek, because of its unparalleled and marvelous structure for expressing ideas, and notably its power to express ideas related to science in the most accurate, the most concise and clearest manner yet devised by man. In this regard it was as perfect as English was deficient in power to express relation between things. Greek showed matchless value.

Dr. S. S. Burt acknowledged that Greek was a beautiful and desirable language, but his judgment told him that English was destined to be the dominant language, for the reason that the English people were becoming the dominant race. He did not believe any language would be agreed upon except it were that of the people who were in the ascendency, in whose speech affairs of government were transacted, and science, art and literature were recorded.

The president, Dr. Roosa, spoke very feelingly upon the collegiate way of teaching languages. He had devoted a great deal of time to Latin and Greek, and, like the other gentlemen who had spoken, felt that what he knew to-day was very little indeed. He started to study German in the same manner, and after some time found himself in Bremen unable even to make known his wishes as to a hotel. There he entered a German family where not a word of English was spoken, had no English acquaintances, and the result was that in two months' time he could go about all Germany and make his wants known without difficulty.

If we were to have an international language it could only be, as Dr. Thomson had said, by a revolution of teaching methods, and Dr. Roosa despaired of such a revolution, because the hide-bound notions of college professors were simply beyond any ordinary assault; for a man from New York to talk to men from Cambridge or New Haven as to ways of teaching would be very much as if he should go to the tomb of the prophet with his boots on.

[FROM LIPPINCOTT'S MAGAZINE.]

## HOW I GAINED AN INCOME.

To support and educate a family is not an easy task. So much every one will admit. Men, fully equipped for such an end, having had it held before them from early boyhood, find it difficult of accomplishment, and often, if complications of ill health or misfortune arise, impossible. Perhaps, therefore, a woman who has accomplished so much may have a claim, even if a very modest one, to success, and may the less hesitate to urge the claim if in doing so she is forced to admit failure in other respects. I will begin, therefore, by confession that I certainly have not, so far, attained the goal of my early ambitions. I have no name well known in the world of letters, and am not in a position to boast of my literary attainment. I have simply succeeded in educating my children, thoroughly equipping them for an independence which was mine only after much suffering and effort, and in securing a comfortable income for myself and the prospect of an independent old age. Yet I venture to hope that possibly my experience may have a greater value for discouraged women than if it had lain among the laurels of literature.

My intention, when I entered the field as a bread winner some ten years ago, was distinctly to be a literary light, possibly even a star of magnitude. Indeed, in the earlier days of returned manuscripts I considered journalism as entirely beneath my consideration, and when, through force of circumstances, I reluctantly entered upon the thorny path familiar to all writers for the press, I did so with the flattering belief that as an art critic I had little in common with journalists as such, and still less with reporters, whom I then held in light esteem.

Alas for my egotistical conceit! I soon had reason to learn that I was but a minnow in the ocean of journalism. A very short experience of the outskirts of the world of letters taught me two things very thoroughly, one being that to gain any hearing at all it was necessary to possess more than mere ability; the other, that sympathy for me as a woman with three children to support might help me over the threshold, but certainly would not secure me an income.

But, after all, these are important lessons, and I may at least claim for myself that I learned them quickly, whereas in many cases they are either not learned at all or are acquired too late for the knowledge to be of practical advantage. Yet even after I had realized them as facts it took me several years to put them into practice: I might never have done so but for the plain speaking of a business friend. One day, in deep discouragement, I was bemoaning the difficulties I met with—the unpleasantly frequent occurrence of rejected manuscripts, for example—and mournfully declaring that, although I had put all my ambitions aside, and become not only a journalist and reporter, but a perfect hack, doing all sorts of odds and ends of miserably worthless work, writing up openings, and scampering round New York and Brooklyn like an overdriven steed for a mere pittance, I could barely meet my necessary expenses and could by no possibility give my children the advantages I desired. He fell upon me somewhat in this wise:

"I am not surprised at it. I never expect to see you doing anything but struggling. There's no money in *your* line. But of course you look down upon us business people, who could buy up all the poor authors in New York City and not miss the money. I could soon show you how to make money. How do you suppose I make mine? But you would never do it, and would probably think it beneath you."

It had not, indeed, occurred to me to ask where my friend's wealth came from. I knew that his family lived comfortably and that he was considered a person of means, and my interest in the matter remained languid even after his explanation was made. It conveyed but little intelligence to my mind when he went on to state that he had been the advertising manager for a large firm, and added, with a certain complacent confidence, that much of its success was owing to his efforts.

Advertising, indeed, only suggested to me columns of enormous type, inartistic cuts, and general vulgarity. The mere thought of such a method of gaining an income was revolting to me, when at last it dimly dawned upon my mind that there might be something in such a plane of effort worthy of consideration. But sometimes changes in our destiny are brought about by very simple agencies; and I owe it entirely to that shot of my friend's, fired apparently into the air, that to-day I am in comfortable circumstances, possessed of more or less property, that my children are fully equipped for their own place in life (which is by no means a low one), and that old age, as it slowly advances, possesses no terrors for me—if indeed I should at forty-eight, in these days of rejuvenescence, dare to consider myself even middle aged. But hard work and much anxiety do not keep one youthful, and my contemporaries must forgive me if I confess that my main object now is to continue to prosper in my undertakings in such a way as to secure an independence to the end.

This record being in some sort a confession, I feel that it is incumbent upon my honesty to admit that more than mere pride was broken down before I seriously turned my attention to the field of money getting suggested to me in which I have since succeeded. Grief entered my life, and ambition died before it—personal ambition, I mean—while the desire for my children's welfare remained as strong as ever. It no longer seemed a matter of any importance to win that name in the world of letters which had so long appealed to my love of fame. I turned from the grave of my son to the fortune of my daughters: money alone could secure for them the fuller, higher education with which I desired to equip them. The first step in its accumulation was taken when I ordered an unobtrusive little card to be printed for circulation among business houses, stating that, as an experienced writer, I was willing to prepare advertisements, letter heads, and circulars.

This modest card I inclosed in personal letters, addressed to the heads of firms which I selected from the business directory. I can but smile as I recall the absolute ignorance which I displayed in the whole matter, and yet, possibly, it was the unconventional method of my address which won me a hearing. Be that as it may, the very first batch of such letters sent through the mail brought me two replies requesting me to call. One was from a large clothing house, the other from a manufacturer of wall paper. Perhaps I never in my life received a more complete setback than when, in each case, after being introduced into the sanctum of the head of the firm, I was asked what I had to propose as advantageous for their line of business. I, in my utter ignorance and incapacity, had expected all proposals to come from them; and there I sat dumfounded, face to face with my own emptyheadedness. However, my woman's wit came to my aid. I said, "I must first know the nature of the business before I can offer suggestions." I can laugh now as I recall how often this lucky hit saved me from appearing the fool I really felt; for it always enabled me to add that, as much of what I heard was new to me, I should like to consider it, and call again when I should have a proposal to make. Some of my proposals must have been amusing. What consultations I had with my business acquaintances after such interviews! What absurd suggestions I often made, and how difficult I should have found it to carry many of them out had they been accepted, my readers may imagine. But, although I made endless mistakes and met many serious rebuffs, I soon realized the truth of my friend's assertion that money could be made in the business world. Whereas every editor of whom I had any experience had been personally sympathetic and yet sorry to see me and glad to get rid of me, every business man I have ever approached has looked upon me as a possibly profitable vehicle, has never dreamed of offering me sympathy, but has been able and willing to pay liberally for any work I undertook and thoroughly accomplished.

At that time trade journals were not as common as they have since become, and one of my earliest successes in the advertising world was the publication of a small magazine for a firm of very good standing, "rushing in," like the proverbial fool, where in the acquired wisdom of experience I should now hesitate to enter. I undertook the whole business—editing, illustrating (looking up artists for this purpose), printing, publishing, and circulating. To be candid, I had not the smallest idea of the responsibility I had undertaken. No book of value ever launched upon the ocean of literature has been born with greater pangs than this twopenny halfpenny little advertising magazine. What pride I had in it! What immense trouble I took! What agonies I endured when printers and artists conspired, as it appeared to me, to thwart my intentions! It was my first effort in the field of pure money making *versus* fame seeking. Well, it was, in its small way, a success. The first issue was followed by many succeeding numbers, and although it came out only quarterly, it served a most useful purpose in my new scheme of life. I carried a copy of it everywhere, and it answered as a passport more thoroughly than any mere introduction could have done. Could I not proudly assert that I had written every article in it myself, printed and published it, without any trouble to the merchant? It led to many more such orders, and ultimately to regular salaried engagements.

How funny my work was sometimes! I remember, early in this experience, undertaking to write a pamphlet upon the effect of electricity upon the circulation of the blood, for which I was to be paid only if, upon its being read to a committee, it proved perfectly satisfactory. The ordeal of reading before the committee, which consisted of six organizers of a company, was severe; but I had asked a good price for it, and came out triumphant. I don't think there was much accuracy of knowledge among the judges of my performance. Nor shall I ever forget the first terrible efforts in my new field of work when they took the form of canvassing from store to store to obtain orders for pamphlets or descriptive articles. Well indeed do I remember starting out each bright morning, determined to call upon at least thirty stores and interview as many of the managers as I could induce to see me. Ah, well, the rebuffs I gained were hard to bear; many a day I returned in tears: and yet they were few in comparison to the rejected manuscripts of the past. In a shorter time than seems credible, within one year from the start, I was being offered salaries of forty and fifty dollars a week to attend to the advertising details of good firms.

What an education it has been! One such position I occupied, and from the experience gained there was able, upon leaving it, to double and treble the good salary I received. If fame remained as far off as ever, there was abundant compensation in a full purse, in a home slowly growing up, in children's lives made happy and their future assured. Soon there was money to invest, and enough insight had been gained in the business world to make such investments profitable. In time managing other people's businesses developed into carrying one on independently, and experience still confirms the wisdom of my friend's advice.

When, in these later years, scarcely a day passes over my head without an appeal from some struggling woman for help or advice, it has seemed to me that a frank record of my own experience as a bread winner would be helpful to them; they may more readily forgive my constant assertion that ignorance and incompetency are the true lions in the road to success when I own how incompetent I have been myself. A valued friend of mine, a lady doctor widely known throughout New England, gave me one of the most valuable lessons of my life by calmly remarking, after I had been deploring one of my many failures, "Well, my dear, you overrated yourself, you see." That is just it. We are all so apt to overrate ourselves, and there is nothing like a business experience for knocking the conceit out of one. Women more particularly, who, being refined and fairly well educated, are thrown upon their own resources, and who in their own circles have been accustomed to a sort of success, who can write bright letters, or do a little painting or decorative needlework, enter the bread winner's field imagining that they must succeed because their friends consider them exceptionally clever. There never was a greater mistake. The business world pays only for what it wants, and if women—and men too, for that matter—would take this truth home to them and ponder upon it, much heartbreaking disappointment would be spared them and their friends. For this is what the market value of a thing really means; it will fetch only what it is worth.

I recall with shame how earnestly and how vainly a well wisher of mine, an eminent publisher, tried many years ago to impress this fact upon my mind. "You will succeed," he used to say, "as soon as you produce what somebody wants, but not so long as your merit is only that of a woman who is struggling." In common with a great many other women not brought up to work, I had a vague sort of idea that my misfortunes were a passport and would gain me an income. Let me assure every woman similarly placed that they never will. Sympathy is readily awakened, but it is in the nature of things shortlived. Respect for effort earnest and continued is a much better ally. In an experience ranging over many years, I must honestly say that every time I have failed it has been through my own ignorance and incompetency, and that my success has been built up upon failures many and severe. The best equipment that either men or women could have is definite knowledge, if it be only of one thing. The first question I ask those who come to me for advice is, "What can you do?" If the answer is—as it almost invariably proves to be—"Anything," my heart fills with despair for the applicant. In the money making world, "anything" means "nothing;" it is overrun with a vast army of incapables ready to rush in and undertake "anything." What is needed is some one who can do something, as opposed to any one who can do anything. Competency is the only equipment that is worth anything nowadays.

In the world of letters a fleeting success may be gained by a brilliant writer, but not a tangible, money-making success unless there is some knowledge behind the brilliancy. In the world of business, incomes are results, not of brilliant incompetency, but of accuracy, method, devotion, steady application, often of attention to things of so little apparent value that the educated but inexperienced woman entering the world of work considers them as of little importance, while upon them may hinge the success of a large business. It is a trite thing to speak of "character" as an important factor in success, but it is pre-eminently so in the business world; and many a woman has failed simply because she has not learned the value of punctuality or looked upon it in the light of "character." Yet honor in the business world is built up upon it. The punctual discharge of obligations is the key note of business reputation; to be "as good as one's word" is equivalent to capital.

How trivial such statements seem! But life is made up of little things, and I have seen many brilliant careers cut short by neglect of them, as I have also watched, in the passing years, the gradual acquirement of property by women who had nothing to commend them to their employers but steadiness and punctuality. Woman to-day should reflect that they can enter any field of work they choose. No one forbids them; all they have to do is to prove their competency when they *have* entered it, and the reward will be theirs. It sounds unsentimental, but it expresses a very sincere conviction when I add that I do not believe that any thoroughly competent person need long seek work in vain in New York City, and this is not in any special direction, but in all. There is always room at the top, and indeed plenty to spare a long way before the top is reached. While it is true that mechanical inventions tend more and more to the demand for specialized knowledge of certain branches of manufacture and trade, and thus sometimes compel a corresponding degree of ignorance of other branches, it is not less true that the qualities which command actual success are the same always and everywhere: they are punctuality, earnestness, devotion to detail. Such qualities cover a multitude of the shortcomings of ignorance; and, whatever may be true of the wonderful "coming age," in the present conditions of the business world no one need starve who possesses them and is imbued at the same time with a willingness to learn.

In my later experience as an employer of labor, these home truths are daily impressed upon my mind. How difficult it is to secure good and faithful service, how rare to find intelligence wedded to punctuality and regard for trifles! I am sure I only echo the thoughts of hundreds of employers when I ask, "Where, in the vast army of the unemployed, of which we hear so much, is the man or woman who will fill the positions I have to offer?" Echo answers and always will answer, "Where?" until more persons learn to lay aside vague yearnings for imaginary honors and accept faithfully the limitations and responsibilities of every-day business life. Its rewards may not be so tempting as the glittering bubble of fame, but they are a good deal more substantial, and what is more to the point, more likely to be reached.—*A Bread Winner.*

## LIGHT.

### POINCARE ON MAXWELL AND HERTZ.*

AT the time when Fresnel's experiments compelled all researchers to admit that light is due to the vibrations of a very subtile fluid filling the interplanetary spaces, the researches of Ampere made known the mutual actions of currents, and founded electrodynamics.

But one step more was required to suppose that this same fluid, the ether, which is the cause of luminous phenomena, is at the same time the vehicle of electrical actions. This step Ampere's imagination enabled him to take; but the illustrious physicist, while announcing this seductive hypothesis, did not see that it was so soon to take a more precise form, and receive the beginning of its confirmation.

It was still, however, but a dream without consistence, till the day when electric measures indicated an unexpected fact—a fact recalled by M. Cornu in the last *Annuaire*, at the end of his brilliant article devoted to the definition of electric units. To pass from the system of electrostatic units to the system of electrodynamic units, a certain transformation factor is employed, the definition of which I will not recall, as it is to be found in M. Cornu's article. This factor, which is also called the ratio of unities, is precisely equal to the velocity of light.

The observations soon became so precise that it was impossible to attribute this concordance to chance. One could not doubt, therefore, that there were certain

* Translation of an article by M. Poincare, in the *Annuaire* of the Bureau des Longitudes for 1894.—*Nature.*

intimate relations between the optic and the electric phenomena. But the nature of these relations would perhaps still have escaped us if Maxwell's genius had not guessed it.

### CURRENTS.

Every one knows that bodies can be divided into two classes: conductors where we prove the transference of electricity, that is to say, of voltaic currents, and insulators or dielectrics. To the old electricians dielectrics were purely inert, and their part consisted in opposing the passage of electricity. If this were so, we could replace any insulating body by another of a different kind without changing the phenomena. Faraday's experiments have shown that it is nothing of the kind.

Two condensers of the same shape and dimensions put in communication with the same sources of electricity will not take the same charge (even if the thickness of the isolating wire be the same), if the nature of the isolating matter differs. Maxwell had made too deep a study of Faraday's works not to understand the importance of dielectric bodies and the necessity of restoring to them their proper function.

Besides, if it be true that light is but an electric phenomenon, it follows that when it is propagated through an insulating body, this body is the place of the phenomenon, therefore there must be electric phenomena localized in dielectrics; but of what nature are they? Maxwell answers daringly: They are currents.

All the experiments up to this time seemed to contradict this; currents had never been observed except in conductors. How could Maxwell reconcile his audacious hypothesis with such a well-founded fact? Why do the hypothetical currents under certain circumstances produce manifest effects which under ordinary conditions remain absolutely unobservable?

It is because dielectrics oppose to the passage of electricity, not a greater resistance than the conductors, but a resistance of a different kind. A comparison will make Maxwell's thought clearer.

If we endeavor to bend a spring, a resistance is encountered which increases in proportion as the spring is bent. If, therefore, we have at our disposal only a limited force, a moment will come when the resistance being unsurmountable, the movement will stop and equilibrium be established; at last, when the force ceases to act the spring will bound back, giving back all the work expended to bend it.

Suppose, on the contrary, that we wish to move a body immersed in water. Here again we meet with resistance which will depend on the velocity, but which, if this velocity remains constant, will not increase in proportion as the body advances; the movement will therefore continue as long as the force acts, and equilibrium will never be attained; finally, when the force ceases to act, the body will not tend to return, and the energy used for making it advance cannot be restored; it will have been entirely transformed into heat by the viscosity of the water.

The contrast is manifest, and it is necessary to distinguish between *elastic* and *viscous* resistance. Then dielectrics would behave, for electric movements, like elastic solids in the case of material movements, while conductors would behave like viscous liquids. Hence two categories of currents; current of displacement or Maxwell's currents which traverse dielectrics and the ordinary conducting currents which circulate in conductors.

The first, having to overcome a sort of elastic resistance, can be but of short duration; for, this resistance increasing continually, equilibrium will be rapidly established.

The currents of conduction, on the contrary, having to overcome a sort of viscous resistance, can consequently last as long as the electromotive force which causes them. Let us look again at the convenient comparison which M. Cornu has borrowed from hydraulics. Suppose we have water under pressure in a reservoir; let us put this reservoir in communication with a vertical tube; the water will rise in it, but the movement will stop so soon as the hydrostatic equilibrium is reached. If the tube is large, there will not be any friction, or loss of charge, and water thus raised could be used for producing work. We have here a picture of displacing currents.

If, on the contrary, the water of the reservoir flows out by a horizontal tube, the movement will continue so long as the reservoir is not empty; but if the tube is narrow, there will be a considerable loss of work and a production of heat by friction. We have here a picture of conducting currents.

Although it is impossible and of little use to try to represent to ourselves all the details of this mechanism, one may say that all happens as if the displacement currents had a number of little springs to bend. When the currents stop electrostatic equilibrium is established, and the springs are so much the more bent as the electric field is more intense. The work accumulated in these springs, that is to say, the electrostatic energy, can be wholly restored so soon as they can unbend themselves. It is thus that mechanical work is obtained when the conductors are allowed to obey the electrostatic attractions. These attractions would thus be due to the pressure exercised on the conductors by the bent springs. Finally, to follow the comparison to the end, the disruptive discharge must be likened to the rupture of overstrained springs.

On the other hand, the work employed for producing conduction currents is lost and wholly transformed into heat like that expended in overcoming the friction or the viscosity of fluids. It is for this reason that the conducting wires get hot. From Maxwell's point of view there are only closed currents. For the old electricians this was not so; they looked upon a current as closed which circulates in a wire joining the two poles of a battery. But if, instead of reuniting the two poles directly, one puts them in communication respectively with the two armatures of a condenser, the instantaneous current, which lasts until the condenser is filled, was considered open; it went, it was thought, from one armature to the other across the wire of communication and the battery, and stopped at the surface of the two armatures. On the other hand, Maxwell supposed that the current traverses the insulating plate, which separates the two armatures, under the form of a displacement current, and that it is thus completely closed. The elastic resistance which it meets on the passage explains its short duration.

Currents can manifest themselves in three ways: by their calorific effects, by their action on magnets and currents, by the induced currents to which they give rise. We have already seen why conduction currents develop heat, and why displacement currents do not do so. On the other hand, however, according to Maxwell's hypothesis, the currents which he imagines must, like the ordinary currents, produce electromagnetic, electrodynamic and inductive effects.

Why have we hitherto been unable to put these effects in evidence? It is because a displacement current, however feeble, cannot last long in the same direction; for the tension of our springs, ever increasing, would soon stop it. There cannot, therefore, be in dielectrics either continuous currents of long duration or sensible alternating currents of long period. The effects will, however, become observable if the alternation is very rapid.

### THE NATURE OF LIGHT.

According to Maxwell, this is the origin of light. A luminous ray is a series of alternating currents produced in dielectrics, or even in the air or the interplanetary vacuum, which changes its direction a thousand billion times every second. The enormous induction due to these frequent alternations produces other currents in the neighboring parts of the dielectric, and it is thus that the luminous waves spread from point to point. Calculation shows us that the rate of spreading is equal to the ratio of the units, that is to say, to the velocity of light.

These alternating currents are a kind of electrical vibrations; but are these vibrations longitudinal like those of sound or transversal like those of Fresnel's "ether"? In the case of sound the air undergoes condensation and rarefaction, alternatively. On the contrary, Fresnel's ether, when vibrating, behaves as if it were formed of incompressible layers, capable only of sliding one over the other. If there were open currents, the electricity going from one extremity to the other of one of these currents would accumulate at one of the extremities; it would condense or rarefy itself like air; its vibrations would be longitudinal. But Maxwell admits only closed currents; this accumulation is impossible, and electricity behaves like Fresnel's incompressible ether; its vibrations are transversal.

### EXPERIMENTAL VERIFICATION.

So we find again all the results of the undulatory theory. But this was, however, not enough to induce the physicists, who were more charmed than convinced, to accept Maxwell's ideas. All that could be said in their favor was that they did not contradict any of the observed facts, and that it was a great pity if they were not true. But experimental confirmation was wanting; it had to be waited for during twenty-five years.

A divergence had to be found between the old theory and Maxwell's, which was not too delicate for our rough means of investigation. There was only one which afforded an *experimentum crucis.*

The old electro-dynamics required electro-magnetic induction to be produced instantaneously; but, according to the new doctrine, it must, on the contrary, be propagated with the velocity of light.

The question was, therefore, to measure, or, at least, to ascertain, the rate of propagation of inductive effects. This has been done by the illustrious German physicist, Hertz, by the method of interferences.

This method is well known in its applications to optical phenomena. Two luminous rays issuing from the same source interfere when they meet at the same point after having followed different paths. If the difference of these paths is equal to the length of a wave—that is to say, to the path traversed during one period, or a whole number of wave lengths—one of the vibrations is later than another by a whole number of periods; the two vibrations are therefore at the same phase, they are in the same direction, and they re-enforce each other.

If, on the contrary, the difference of path of the two rays is equal to an odd number of half wave lengths, the two vibrations are in contrary directions, and they neutralize one another.

The luminous waves are not the only ones susceptible to interference; all periodic and alternating phenomena propagated with a finite velocity will produce analogous effects. It happens with sound. It ought to happen with electrodynamic induction, if the velocity of propagation is finite; but if, on the contrary, the propagation be instantaneous, there will not be any interference.

But one cannot put these interferences to the proof if the wave length is greater than our laboratories, or greater than the space that the induction can traverse without becoming too feeble. Currents of very short period are absolutely essential.

### ELECTRIC EXCITERS.

Let us first see how they may be obtained with the help of an apparatus which is a veritable electric pendulum. Suppose two conductors united by a wire; if they are not of the same potential, the electric equilibrium is broken in the same way as the mechanical equilibrium is deranged when a pendulum is swung from the vertical. In the one case as in the other, the equilibrium tends to re-establish itself.

A current circulates in the wire and tends to equalize the potential of the two conductors in the same way as a pendulum seeks the vertical. But the pendulum will not stop in its position of equilibrium; having acquired a certain velocity, it passes this position because of its inertia. Similarly, when our conductors are discharged, the electric equilibrium, momentarily re-established, will not maintain itself and will be destroyed by a cause analogous to inertia; this cause is *self-induction.* We know that when a current stops it gives rise in the adjacent wires to an induced current in the same direction. The same effect even is produced in the wire in which the induction current circulates, which finds itself, so to speak, continued by the induced current.

In other words, a current will persist after the disappearance of the cause which produced it, as a moving body does not stop when the force which had put it in motion ceases to act.

When the two potentials shall have become equal, the current will therefore continue in the same direction, and will make the two conductors take opposite charges to those which they had to start with.

In this case, as in that of the pendulum, the place of equilibrium is passed; in order to re-establish it, a backward movement is necessary.

When the equilibrium is regained, the same cause immediately destroys it, and the oscillations continue without ceasing.

Calculation shows that the duration depends on the capacity of the conductors; it suffices, therefore, to diminish sufficiently this capacity, which is easy, to have an electric pendulum susceptible of producing alternating currents of extreme rapidity.

All this was well established by Lord Kelvin's theories and by Feddersen's experiments on the oscillating discharge of the Leyden jar. It is, therefore, not this which constitutes the original idea of Hertz.

But it is not sufficient to construct a pendulum; it must also be put into movement. For this, it is necessary for some agent to move it from its position of equilibrium, and then to stop abruptly—I mean to say, in a time very short in relation to the duration of a period; otherwise the pendulum will not oscillate.

If, for example, we move a pendulum from its vertical position with the hand, and then, instead of loosing it suddenly, we let the arm relax slowly without unclasping the fingers, the pendulum, still supported, will arrive at its place of equilibrium without velocity, and will not pass it.

We see then that with periods of a hundred-millionth of a second, no system of mechanical unclamping could work, however rapid it might appear to us with regard to our usual units of time. This is the way in which Hertz has solved the problem.

Taking again our electric pendulum, let us make in the wire, which joins the two conductors, a cut of some millimeters. This cut divides our apparatus into two symmetric halves, which we will put in communication with the two poles of a Ruhmkorff coil. The induced current will charge our two conductors, and the difference of their potential will increase with a relative slowness.

At first the cut will stop the conductors from discharging themselves. The air plays the part of an insulator, and keeps our pendulum away from its position of equilibrium.

But when the difference of potential becomes large enough, the jar spark will pass, and will make a way for the electricity accumulated on the conductors. The cut will all at once cease to act as an insulator, and by a sort of electric unclamping, our pendulum will be freed from the cause which prevented it returning to its equilibrium. If the complex conditions, well studied by Hertz, are fulfilled, this unclamping is sudden enough to enable oscillations to be produced.

The apparatus, called an "exciter," produces currents which change their direction from 100,000,000 to 1,000,000,000 times per second. Because of this extreme frequency they can produce inductive effects at a great distance. In order to render these effects simple, another electric pendulum, called a "resonator," is employed. In this new pendulum, the cut and the coil, which only serve for the unclamping, are suppressed; the two conductors reduce themselves to two very small spheres, and the wire is bent back in a circle in a way to approach the spheres to each other.

The induction due to the exciter will put this resonator in vibration the more easily as the periods of the two are less different. At certain phases of the vibration, the difference of potential of the two spheres will be large enough to produce sparks.

### PRODUCTION OF INTERFERENCES.

We have thus an instrument which shows the effects of an inductive wave emitted from the exciter. We can study what happens in two ways: either expose the resonator to the direct induction of the exciter at a great distance, or else make this induction work at a short distance on a long conducting wire, along which the electric wave will go, and which will work in its turn by induction at a short distance on the resonator.

Whether the wave propagates itself along a wire or across the air, one can produce interferences by reflection. In the first case, it will reflect itself at the extremity of the wire, which it will follow again in an inverse direction; in the second, it will reflect itself on a metallic leaf which acts as a mirror. In the two cases the reflected wave will interfere with the direct wave, and we can find places where the spark of the resonator will cease to pass.

The experiments made with the long wire are easier; they furnish us with very precious instruction, but they will not serve as *experimenta crucis;* for in the old as well as the modern theory, the quickness of an electric wave along a wire must be equal to that of light. The experiments on the direct induction at a great distance are, on the contrary, decisive. They show that not only the quickness of propagation of induction across the air is finite, but that it is equal to the quickness of the wave propagated along a wire, complying with the ideas of Maxwell.

### SYNTHESIS OF LIGHT.

I shall insist less on other experiments of Hertz, more brilliant, but less instructive. Coucentrating with a parabolic mirror the wave of induction taken from the exciter, the German savant obtains a veritable cluster of electric rays, capable of reflecting and refracting themselves regularly. The rays, if the period, already so small, were a million times shorter still, would not differ from the luminous rays. We know that the sun gives out several kinds of radiation, some luminous because they act on the retina, others obscure ultra-violet or infra-red, which manifest themselves by their chemical or calorific effects. The first only owe their qualities, which make them appear to us of a different nature, to a kind of physiological chance. To the physicist the infra-red does not differ more from the red than the red from the green; the length of a wave is only greater; those of the Hertzian radiations are much greater still, but there are only differences of degree, and one may say, if Maxwell's theories are true, that the illustrious Professor of Bonn has realized a veritable synthesis of light.

### CONCLUSIONS.

But our admiration for so much unhoped for success

must not make us forget the progress which still remains to be accomplished. Let us therefore try to exactly summarize the results which are definitely attained.

First, the velocity of direct induction across the air is finite, without which the interferences would be impossible. The old electro-dynamics are therefore condemned. What must one put in its place? Is it Maxwell's theory (or at least something approaching it, for one would not expect the divination of the English savant to have foreseen the truth in all its details)? Although the probabilities accumulate, the complete demonstration is not yet reached.

We can measure the length of a wave of Hertzian oscillations; this length is the product of the period by the velocity of propagation. We should, therefore, know this velocity if we knew the period; but this last is so small that we cannot measure it; we can only calculate it by a formula due to Lord Kelvin. This calculation leads to numbers which agree with Maxwell's theory; but the last doubts will only be done away with when the velocity of propagation has been directly measured.

This is not all: things are far from being so simple as one might think, from the above short account. Diverse circumstances come to complicate them.

First, there is round the exciter a radiation of induction; the energy of this apparatus radiates, therefore, externally, and as no fresh source comes to supply it, it soon disperses, and the oscillations die out very rapidly. It is here that one must look for the explanation of the phenomenon of multiple resonance, which was discovered by MM. Sarasin and De la Rive, and which at first appeared irreconcilable with the theory.

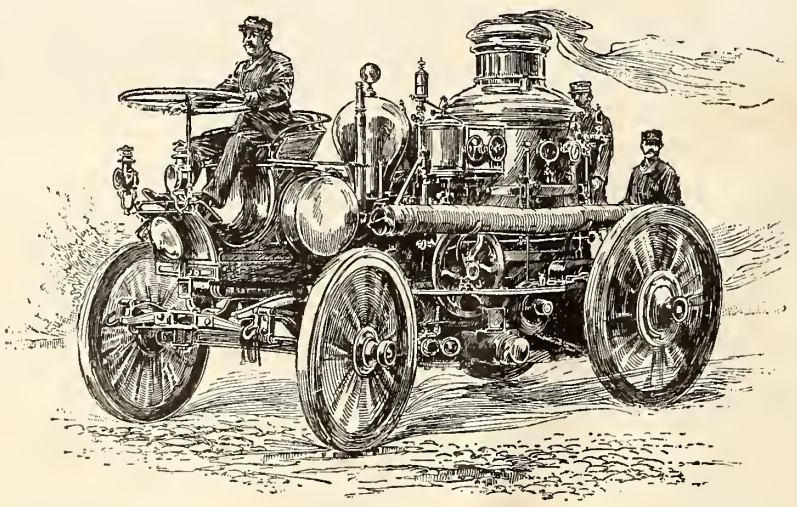
On the other hand, we know that light does not precisely follow the laws of geometrical optics, and the difference which produces diffraction is more considerable as the length of the wave is greater. With the great length of the Hertzian undulations these phenomena must assume an enormous importance and trouble everything. No doubt it is fortunate, for the moment at least, that our means of observation are so coarse, otherwise the simplicity which seduced us at the first sight would give place to a labyrinth where we should be lost. It is from this probably that different anomalies arise, which have hitherto not been explained. It is also for this reason that the experiments on the refraction of rays of electric force have, as I said above, but little demonstrative worth.

There still remains a difficulty which is more serious, but which is, no doubt, not insurmountable. According to Maxwell, the coefficient of electrostatic induction of a transparent body ought to be equal to the square of its index of refraction. This is not so. The bodies which follow Maxwell's law are exceptions. We are evidently in the presence of phenomena much more complex than we thought at first; but one has not been able to explain anything, and the experiments themselves are contradictory.

There still remains, therefore, much to be done. The identity of light and electricity is from to-day something more than a seducing hypothesis: it is a probable truth, but it is not as yet a proved truth.

## THE LARGEST FIRE ENGINE.

The city of Hartford, Connecticut, is proud in possessing the largest and most powerful locomotive steam fire engine in the world. Over 10 ft. high and 17 ft. long, it weighs 8½ tons, and can throw 1,350 gallons of water per minute. The boiler contains 301 copper tubes. This engine, at her first trial, threw, through 50 ft. of hose 3½ in. in diameter, a horizontal stream of water a distance of 348 ft., and threw two streams, each as large as that thrown by an ordinary fire engine, a distance of over 300 ft. The road driving power of the engine is applied through two endless chains running over sprocket wheels on each of the main rear wheels, permitting these wheels to be driven at varying speeds when turning corners. The engine may be run either forward or backward, and can be stopped inside of fifty feet when running at full speed. When in the house the boiler is connected with steam pipes from a heater in the basement, and steam is always kept up to about ninety-five pounds, which would run her about a quarter of a mile. The fire box is kept full of material ready for lighting, and a steel arm under the engine carries a quantity of waste saturated with kerosene oil in close proximity to a card of matches in a holder under a scratcher, the latter being attached to a cord tied to a ring in the floor. At an alarm of fire the steam pipes are disconnected, the throttle opened, and, before the engine has moved six inches, the cord



"JUMBO," THE LARGEST STEAM FIRE ENGINE IN THE WORLD.

pulls the scratcher, and the rod carrying the blazing waste swings around under the fire box, igniting the shavings and wood. Cannel coal is burned, and steam enough can be generated in two minutes to run the engine at a speed of thirty-one miles an hour.—*The Graphic.*

## ELECTRIC DISCHARGE THROUGH GASES.

Prof. J. J. Thomson, F.R.S., lectured at the Royal Institution lately on the "Electric Discharge through Gases," demonstrated by a considerable number of experiments, including those described below, and illustrated by the accompanying cuts, which we take from the *Engineer*.

Fig. 1 represents a tube with a thin piece of platinum leaf stretching across the middle and provided with a branch passage which communicates with a barometer tube. When the side tube is open the discharge, instead of crossing the platinum portion, goes the longer way round by the side tube. When the cistern of the barometer tube is raised so as to close the side tube by a pellet of mercury, the discharge is forced back through the main tube.

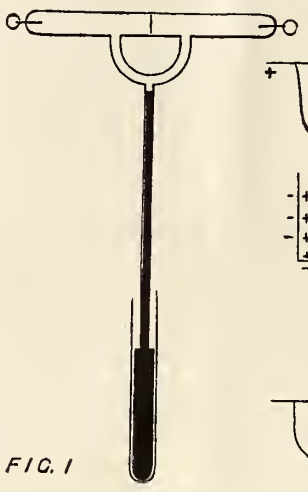


FIG. 1

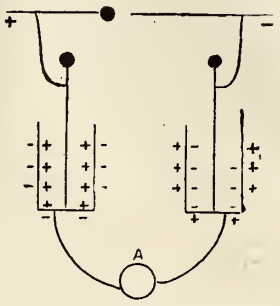


FIG. 3

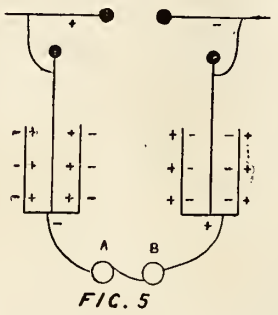


FIG. 5

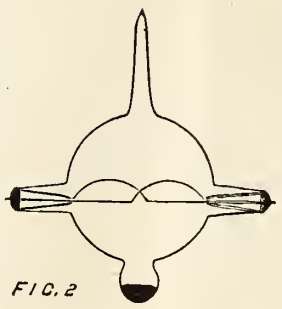


FIG. 2

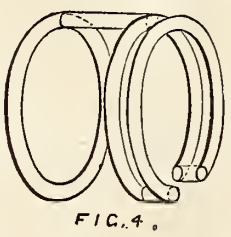


FIG. 4.

FIG. 6

Fig. 2 represents the arrangement for an experiment showing the reluctance of the discharge to leave the gas and enter the metal. The discharge is an alternating one, and instead of going straight across between the terminals, it goes from the point of one to the base of the other; the terminal from the tip of which the discharge starts is the positive one.

Fig. 3. An arrangement to produce discharge through a bulb without electrodes. The bulb is placed inside the coil, A, which connects the outsides of two Leyden jars, whose insides are connected to the two terminals of a Wimshurst machine or of an induction coil. When a spark passes, rapidly alternating currents pass through the coil and induce the discharge in the bulb.

Fig. 4. Two tubes filled with the same gas at the same pressure, one forming a simple ring, the other bent back upon itself. When this arrangement is placed inside the coil the discharge passes through the simple ring, but not through the other. In the first case the total electromotive force round the ring is finite, in the second it vanishes.

Fig. 5. Apparatus for testing the conductivity of various substances by means of these electrodeless dischargers. A standard bulb is placed in A, and the conductivity of the substance is tested by seeing the effect it produces when placed in B upon the brilliancy of the bulb in A. By this method it was shown that the molecular conductivity of a rarefied gas conveying a discharge was greater than that of the best conducting metal.

Fig. 6. Arrangement to show that at excessively low pressure the discharge cannot pass through a rarefied gas. The inner bulb contains gas at a pressure at which a discharge passes. The outer bulb is a mercury vacuum. When the apparatus is cold no discharge passes through the outer bulb, but one goes through the inner. When the apparatus is warmed, so that the pressure of the mercury vapor is higher, the discharge goes through the outer, but not the inner. The outer bulb being now a conductor, shields the inner from the effects of the alternating currents in the coil.

Fig. 7. An experiment to show that the discharge is stopped when it has to go across the lines of magnetic force, and facilitated when it goes along them. When the magnet is "off" the discharge passes through the

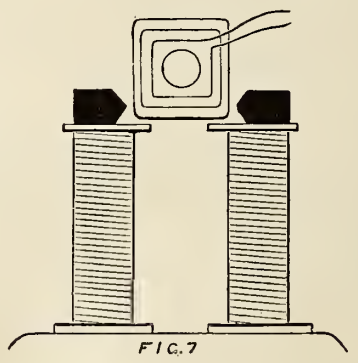


FIG. 7

inner bulb, but not through the outer square tube. When the magnet is "on" the discharge goes through the outer tube, but not through the inner.

## FOREIGN METALS IN COPPER.

The following is the method adopted by the author: Twenty-five grammes of the sample are dissolved in a mixture of 200 c. c. of water, 100 c. c. of pure concentrated sulphuric acid, and 45 to 46 c. c. of nitric acid of sp. gr. 1·21. The quantity of the last named reagent is reckoned so as to afford a small excess over that necessary for the oxidation of the quantity of copper taken, while the amount of sulphuric acid represents a considerable surplus, in order to prevent the separation of basic salts of bismuth and antimony when the solution is subsequently diluted. When the whole of the copper is dissolved, the solution is diluted with 200 c. c. of water to prevent the formation of crystals of copper sulphate. The resulting liquid is generally clear, but it may be turbid from the separation of insoluble antimoniates of copper and bismuth, which must in that case be filtered off and examined separately. The original solution, or the clear filtrate, as the case may be, is warmed to 40° C., and treated with sulphur dioxide in a rapid stream to decompose the remainder of the nitric acid, the reduction being complete in about half an hour, provided the temperature specified, which is the most favorable for the reaction, be observed. The solution, which should smell of sulphur dioxide, may be turbid from the presence of metallic silver precipitated by the reducing agent. Should it be desired to determine the silver in the wet way, the precipitation of traces not reduced by the sulphur dioxide is effected by the addition of a few drops of hydrochloric acid and the mixed precipitate of silver and silver chloride filtered off, converted completely into chloride and weighed in the usual manner. If, on the other hand, a dry assay for silver is to be made, the turbidity due to the separation of metallic silver may be disregarded, and the main body of liquid, together with the trace of metallic silver, is transfixed to a two-liter flask and precipitated with pure potassium thiocyanate, a rapid stream of sulphur dioxide being meanwhile maintained. A slight deficiency of potassium thiocyanate is used, so that a small fraction of the copper may remain in solution. The solution of potassium thiocyanate is of such strength that about 500 c. c. are required to precipitate 25 grammes of copper. The total bulk is then made up to two liters, the precipitate allowed to subside and a known volume of the supernatant liquor filtered off; 1,800 c. c. is a convenient amount to take. The excess of sulphur dioxide is driven off by evaporation, and the foreign metals originally present in the copper, such as antimony, arsenic, bismuth, tin, iron and nickel, are separated and determined by the customary analytical methods. In making the calculations of the analysis it is necessary to correct for the volume of the cuprous thiocyanate in order to ascertain with what fraction of the 25 grammes of copper originally taken the quantity of liquid drawn off after precipitation corresponds. This involves a knowledge of the specific gravity of cuprous thiocyanate. The author has determined this value, and finds it to be 2·999, so that the volume occupied by the cuprous thiocyanate from 25 grammes of copper is 15·98 c. c. The total bulk of liquid in the two-liter flask may therefore be taken as 1,984 c. c., and the relation between this number and that of the liquid drawn off, viz., 1,800 c. c., determines upon what fraction of the 25 grammes of copper the estimation of foreign metals has been effected. Test analyses of pure copper, to the solution of which known quantities of impurities had been added, prove the accuracy of the method.—*W. Hampe, Chem. Zeit.*, 1893, *xvii.*, 1691-92; *The Analyst.*

An extraordinary incident is reported from Trealaw, South Wales. A truck of cattle, sheep, and pigs was being discharged at the station, when it was discovered that the pigs had devoured three sheep, the skins and bones only remaining. The pigs' mouths were covered with blood.

## MANUFACTURE OF OAKUM.

OAKUM is manufactured from the old hemp rigging taken from American and English vessels. American rigging is considered the best on account of its not being so heavily coated with tar as the English rigging, which, with the use of lukewarm water, makes it less difficult to separate fiber.

The old rope is first cut up into 8 to 10 ft. lengths, and then fed into a cutting machine. This machine contains two steel knives, about 18 in. in length. The upper, or movable, has a stop at one end of the blade, which prevents the rope when being cut from slipping. The attendant passes the end of the rope along the top of the bottom blade to the stop of the upper blade, which, in descending, cuts the rope off into 6 in. lengths. From the cutting machine they are taken to a soaking or softening tub, where they are steamed from 5 to 15 minutes. This softens the rope so that the strands can be separated by hand. After steaming they are then taken to the washing machine. This machine is oval-shaped, and made mostly of oak. It is about 15 ft. in length, 10 ft. in width, and about 4 ft. in height. On one side, across the center of the machine, is a shaft connected to which are 8 oak paddles, 3 ft. long and 1½ ft. in width. These paddles revolve inside of a 4 ft. channel containing the rope to he washed. Attached to a similar shaft on the other side of the machine, across the center, are three slightly curved iron arms which, when revolving in the channel, throw out the material after washing. The strippers, 6 in. in diameter, and 1 doffer, 2 ft. in diameter. The machine is fed in the manner as the pickers. The material passing between the rollers and taken up by a worker, then stripped and brushed or fanned, then passed between another worker and main cylinder to be stripped and brushed again, and so on until every particle of dirt is separated from the fiber. After passing between the doffer, a large cylinder, it falls down through a shaft below, where it is taken up and weighed and pressed into 50 lb. bales. Twenty-five hands can turn out about 100 bales per day, with 1 cutter, 2 washers, 2 pickers, and 3 finishers. The sketches were taken from the plant of B. Mills' Sons, Jersey City.

[Continued from SUPPLEMENT, No. 959, page 15325.]

## THE MANUFACTURE OF STRAW CELLULOSE.*

By JAMES BEVERIDGE.

### III.—YIELD, ETC.

IT has always been the aim of manufacturers to obtain the highest yield of cellulose from unit weight of straw, and to this end various modifications of the soda process have been suggested and worked on a manufacturing scale. A process with this intent was brought out some years ago by Leunig and worked by an English company, but the results were very indifferent. Caustic soda was used to remove the incrusting organic and mineral matters surrounding the fibers substantially in the manner above described, but instead of bleaching with hypochlorites, chlorine gas was employed. This, as is generally known, is a costly and anything but an easy process to carry on economically and free from nuisance, if not actual danger, and it is not surprising that the Leunig process proved unsatisfactory from a commercial point of view.

From what I have previously stated it might be inferred that a sulphite process for the treatment of straw would prove of value, inasmuch as by it the maximum yield of pulp would be obtained for the reasons already given—namely, that cellulose is less soluble in solutions of bisulphites of lime, soda, or magnesia than those of caustic soda. Notwithstanding that this is substantially true, there are yet serious defects attached to the quality of the product which render it practically worthless for use in the manufacture of papers of a high quality.

This arises from the fact that the silica in the straw remains untouched by the bisulphite solutions, and appears in the cellulose in a very objectionable form. When such cellulose is converted into paper, the silica appears upon the surface of the sheet as small shining scales. It is also obvious that there is only one available method of cheaply removing this silica, which consists in dissolving it out with a weak solution of caustic soda. My experiments in this direction have proved that this can be done, and that the cellulose produced by this dual treatment is of first-class quality. The yield, however, remained substantially the same as that obtained by digesting the straw in caustic soda alone. In this, as in the Leunig process, all organic substances readily soluble in weak caustic solutions are removed.

Some very interesting figures on the question of yield which I here reproduce were given in the *Papier Zeitung* some few years ago by Roth. I understand them to be the results obtained in actual manufacture, and as such are very instructive to the pulp and paper maker. They clearly show that the yield from unit weight of straw varies inversely with the quantity of caustic soda used for digesting, and that the amount of bleaching powder required to bleach the pulp varies directly with the yield. Assuming the temperature (or pressure), the time used for digestion, and the quality of the straw with respect to its percentage of cellulose to be kept practically constant, I have found by a long series of experimental trials that the above conclusions are strictly correct.

These manufacturing yields as given by Roth seem to indicate that it is possihle to obtain 50 per cent. of hleached cellulose from straw, but whether the product corresponded in quality to what is found in the market as straw pulp seems to he very doubtful. The fact that 7 cwt. of bleaching powder were required to hleach one ton of it plainly indicates that it was of low quality. It is, of course, possihle to treat straw with weak caustic solutions, to obtain a high yield, but this product cannot be looked upon as "straw pulp" of ordinary quality.

In practice, the actual yield seldom exceeds 40 per cent. In one pulp mill with which I have been connected, working a mixture of oat and wheat straw, with occasionally a small parcel of rye and barley, all grown in Holland, the yield of bleached cellulose containing 10 per cent. of moisture fluctuated over a long period between 40 per cent. and 41 per cent.

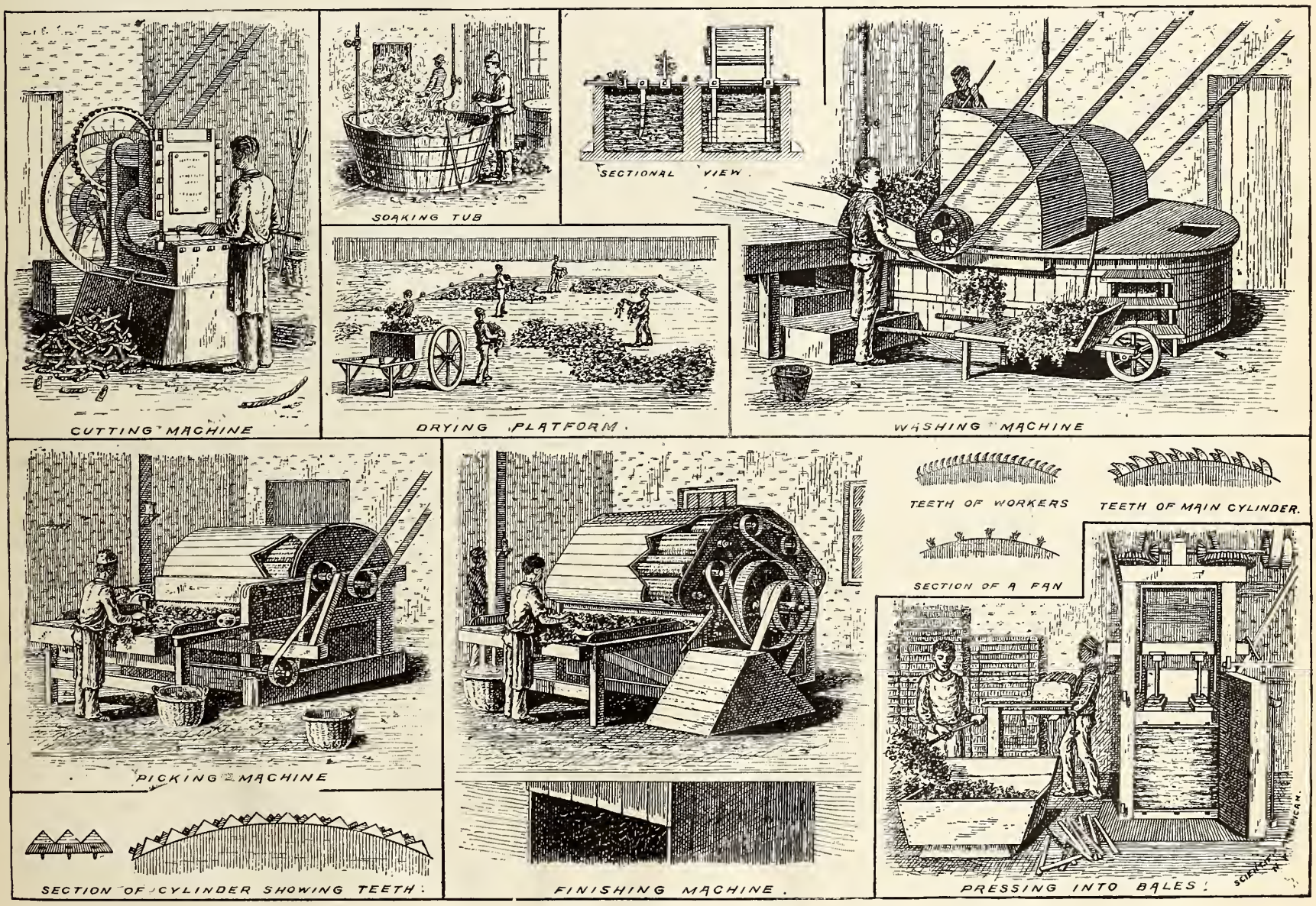
The bleaching powder required to bleach this air-dry pulp varied from 18 to 20 per cent. These results closely correspond to those given by Roth in the Austrian factory.

Lately the so-called "sulphate process" has been applied in a German factory, and as the digesting fluid consists largely of sulphide of sodium, which, as might be inferred from its properties, has a less solvent action on the cellulose than caustic, it is very probable that the yield ohtained in this process exceeds that of the caustic process pure and simple. I am, however, unable to state definitely whether this is so or not, or what the yield actually is.

Passing now from the question of yield, I come to another of great importance, namely, the influence of the quantity of silica in straws on the loss of soda, and a consideration of the methods for mitigating this loss. It is almost unnecessary for me to remind you that the composition and quantity of the ash found in straws varies very greatly. The most complete analyses of the ashes of straws which I have been able to find are those published by Wolff (Ashen Analysen). The following table embraces his average results.

While the straw is being, boiled substantially the whole of the silica passes into solution as silicate of soda. The alkali thus combined is practically lost to the pulp maker, because it is rendered inactive for the process of digestion. The quantity of alkali thus ren-

* From the *Journal of the Society of Chemical Industry.*



COMPOSITION OF THE ASHES OF STRAWS.—WOLFF'S "ASHEN ANALYSEN."

| | Total Mineral Matter in Straw. | Percentage Composition of the Ash. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $K_2O$ | $Na_2O$ | CaO | MgO | $Fe_2O_3$ | $P_2O_5$ | $SO_3$ | $SiO_2$ | Cl |
| Barley straw, average of 4 analyses | 8·10 | 25·75 38·37 | 1·92 3·99 | 7·53 4·23 | 2·62 2·53 | 2·19 1·79 | 3·94 2·66 | 3·91 3·06 | 51·43 35·68 | 3·75 7·99 |
| Oat " " 8 " | 7·77 | 26·28 12·16 | 0·74 1·00 | 11·10 6·82 | 4·45 4·00 | 3·19 1·02 | 8·97 3·20 | 5·57 5·78 | 36·86 65·34 | 3·63 0·60 |
| Rye " " 3 " | 4·32 | | | | | | | | | |
| Wheat straw, one analysis | 3·25 | | | | | | | | | |

dered useless will vary, of course, with the amount of silica contained in that quantity of straw which will produce one ton of air dry bleached cellulose on the quantity of potash rendered soluble, and also on the chemical constitution of the silicate. There being an excess of caustic soda always present, I have assumed the silicate to be a normal one, having the formula $Na_2SiO_3$.

Assuming this to be correct, I have calculated, as shown in Table II., first, the quantity of straw required to produce one ton of air-dry cellulose; second, the amount of silica contained in this quantity of straw; and then, finally, the quantity of soda, reckoned as 60 per cent. alkali ($Na_2O$), which would combine with this silica. Going a step further, by way of example, and assuming 21 lb. of 60 per cent. caustic to be the amount required to digest 1 cwt. of the Dutch wheat straw (Ijpolden) above given, the total alkali (60 per cent.) used to produce one ton of cellulose is 10·29 cwt., and of this 4·39 cwt., or 42 per cent., would be neutralized by this silica.*

It is this loss which increases the cost of soda so enormously in straw cellulose works. Unless the silicate of soda in the waste lyes or the recovered ash can be decomposed in some practical or economical way, or the recovered ash sold as such, the present highly efficient systems of soda recovery by multiple evaporation, by which 80 per cent. of the soda can be easily recovered, are of little value to the straw pulp maker. Indeed, in most cases where the silica approaches in quantity anything like that shown in the table, the recovered ash is of little value for further use in digesting. For reasons formerly stated, it is manifest that the most economical course to follow is to select those straws only for the manufacture which by chemical test are shown to contain the least quantity of silica.

There are several methods, alike in principle, of reconverting this silicate of soda into available caustic alkali. The most simple way consists in adding bicarbonate of soda to the solution of the recovered ash, whereby the silicate is decomposed, normal carbonate of soda being formed with the separation of free silica. The same decomposition can be brought about by pumping gaseous carbonic acid through the liquor, but as this gas is not always available, and the cost of pumping is a serious item, and that the silica thus separated is in a very gelatinous state, this system is not practicable.

Messrs. Sutherland and Kynaston, who took out a patent some years ago for the use of bicarbonate, claim to obtain the silica as a heavy or granular precipitate, in which state it can be separated from the carbonate of soda liquor with comparative ease. The separation of the silica is one of the great difficulties of this process. The use of bicarbonate serves the additional purpose of replacing the alkali which is invariably mechanically lost, but if the quantity of silica and the percentage amount of soda recovered are both great, it can be shown by a simple calculation that the amount of bicarbonate required to effect the decomposition abnormally increases the volume of the alkali liquors in circulation; that is to say, more bicarbonate is used than corresponds to the soda mechanically lost.

The next most important constituent of the ashes of straws that calls for particular attention is potash. While silica is considered as an impurity and of no value, the potash, on the other hand, might be utilized and turned to account. This problem is, however, as difficult to solve as that of getting rid of the silica in the waste soda lyes. If we refer to the table of composition of the ashes of straws, it will be found that the potash is very considerable in quantity, that, in fact, it ranks next to silica in this particular. It appears highest in the oat straw, rye coming next, then barley, and finally wheat. The oat straw contains more potash than silica, indeed, 2·98 per cent. of its weight. Assuming, as before, that 49 cwt. of this straw will yield a ton of bleached cellulose, the amount of potash which passes into solution for this quantity is 1·46 cwt., which represents nearly 14 cwt. of potash alum. The above barley straw would yield a very similar amount, while the rye and the wheat would yield proportionally smaller quantities.

Some years ago I made several experiments with a view to recover the potash if possible in a useful state. The separation of it from the soda is very difficult, and so far as I am aware can only be accomplished in an imperfect way by crystallization. The solubility of carbonate of potash being much greater than that of the corresponding soda salt. Of course it is practically impossible to get the potash by itself in a comparatively pure state in this way, and commercially it is too much contaminated with soda to be of much value, excepting probably in the artificial manure trade. I have, however, attempted to obtain it in the form of an alum by neutralizing the alkalies in the mother liquors, after crystallization, with sulphuric acid, and then adding sulphate of alumina and further concentrating and crystallizing, obtaining a crop of crystals. These, however, consisted largely of sulphate of soda (Glauber's salts), but undoubtedly contained crystals of potash alum.

This method, the principle of which was applied by Newlands many years ago to the recovery of potash from sugar solutions, would be costly to carry out in practice, as it involves first the separation of the silica from the recovered ash; second, the separation of the bulk of the soda from the potash; and finally, the purification of the alum. On the other hand, the advantages of being able to purify the waste lyes, together with the value of the potash recovered, would, I dare say, allow of considerable expenditure in dealing with the problem.

* An allowance of course must be made for the amount of potash present in the straw as a silicate.

### IV.—FUEL, ETC.

It is always an important addition to manufacturing experience to be able to estimate from well-established data the amount of steam or coal consumed in carrying on any manufacture. The difficulties to be overcome in doing this naturally depend on the nature of the operations to be carried out, whether in fact heat is consumed in bringing about chemical reaction, or in the generation of mechanical force by any of the well-known types of steam engines; or in the process of artificial drying or evaporation. All these, namely, heat for (1) accelerating chemical reaction, (2) for generating mechanical power, and (3) for drying, are used in the preparation of straw cellulose; and the conditions of the manufacture being well defined, it is a simple matter to calculate the lowest amount of steam required to perform the various operations in the different departments of a straw pulp factory.

It is not my intention to include in this paper the various formulæ I employ to ascertain these items, as they more properly belong to another subject, but as this paper would be incomplete without reference to the fuel used to produce a ton of cellulose, I will simply state the results I have obtained by the application of these formulæ. It will be convenient to calculate the quantity of steam required for each operation and then to total the amounts.

*a. Steam for Digesting the Straw.*—It is obvious enough that the quantity of steam required to boil straw depends upon the temperature at which the digesting process is conducted, the proportion of caustic lye to straw being in nearly all cases about the same. The higher the pressure or temperature (for the one corresponds to the other), the more heat is required to raise it to that temperature. If, therefore, we know the respective weights and specific heats of the caustic lye, straw and boiler (wrought iron), it will be easy to calculate the total heat units required to raise them to the maximum temperature; and as the heating is done with high pressure steam, it will not be difficult, on the other hand, to calculate the weight of steam that is needed to impart this necessary amount of heat. It is on this principle, one which indeed is applicable to a great number of parallel cases and is commonly known, that I ascertain the lowest amount of steam required to boil straw.

Take the individual case above quoted, in which a charge of 40 cwt. of straw and 16,945 lb. of caustic soda lye of 10½ Tw. were boiled in a wrought iron boiler weighing 7 tons at a maximum pressure of 60 lb. above atmosphere (*i. e.*, 307° F.), there were 4,499 lb. of steam required to raise the boiler and contents to 307° F. This weight of steam represents the lowest amount that can possibly be consumed in performing the work. By a simple proportion sum, the steam needed to digest 49 cwt. or that quantity which produces a ton of cellulose can be ascertained. It is necessary to make an allowance for loss of heat by radiation which invariably takes place, but as this varies in different factories, it can only be properly estimated by direct investigation. My own experience, which is somewhat limited in this particular manufacture, is that an allowance of 20 per cent. is ample for well arranged works in which the steam boilers are in close proximity to the digesters.

*b. Mechanical Power.*—This is usually generated by a steam engine of the simple condensing, compound, or triple expansion type, and as the steam consumed in the development of one indicated horse power per hour by each of these types of engines is generally known, and can, in any case, be estimated with accuracy, if the total amount of power expressed in horse power required to produce a ton of cellulose be known, the steam necessary for this department can be easily calculated. In well arranged works, from 3 to 3½ horse power per hour are required per ton of pulp per week. That is to say, a factory producing 30 tons of air-dry pulp per week will require a mechanical power equal to from 90 to 105 indicated horse power generated continuously throughout the week (144 hours). This power includes the cutting and dusting, disintegration of the pulp, and, in fact, is sufficient to drive the whole machinery of the mill. Assuming a compound engine of modern construction to be used for generating this force, using say 18 lb. of steam per indicated horse power per hour, then we have

$$\frac{90\times18\times144}{30} = 7{,}776 \text{ lb. of steam per ton cellulose.}$$

*c. Drying.*—To ascertain by calculation the amount of steam to dry the wet web of pulp is not so simple, although this case is well defined and can be expressed by a formula of very general application. The wet web of pulp, which contains about 55 per cent. of water, 50 per cent. of which must be driven off, is passed over a series of drying cylinders heated by steam of from 8 to 10 lb. pressure. Having regard to the special circumstances prevailing in such a system of drying, it may be fairly assumed that the water in the wet web is evaporated as steam of 212° F.; and that the water condensed within the cylinders is ejected from them at a temperature corresponding to the steam pressure within, viz.: 8 to 10 lb. per square inch above atmosphere. The steam condensed within the cylinders is a measure of the water evaporated. If we know the amount of water to be evaporated from the wet web per ton of air-dry cellulose made, it is not difficult to estimate the necessary quantity of steam to perform this evaporation. The water to be driven off, as above indicated, may be fairly taken at one ton (2,240 lb.) per ton of cellulose, and the quantity of steam condensed to water of temperature 240° F. (10 lb. steam pressure) inside the cylinders to evaporate this water, *i. e.*, convert it into steam at 212° F. and under atmospheric pressure, is 2,647 lb. In this, as in the first case mentioned, an allowance must be made for loss of heat by radiation. After carefully considering similar cases and making tests, I have come to the conclusion that 15 per cent. of the calculated quantity is sufficiently large to cover this loss, in all cases where there are few stoppages in the drying, and where the ends of the drying cylinders are protected by non-conducting materials.

Collecting these results, we then have per ton of cellulose:

| | Lb. |
|---|---|
| Steam for digesting, including loss of heat by radiation, 20 per cent. | 6,613 |
| Steam for developing the mechanical power | 7,776 |
| Steam for drying, including allowance of 15 per cent. | 3,044 |
| Total steam required | 17,433 |

To convert this into coal, it is necessary to know how much water is evaporated in the steam boilers per lb. of coal burned. Assuming this to be 7 lb. water, the above 17,433 lb. of steam represents 24·9 cwt. of coal. This, according to my observations, is rather lower than that usually used per ton of straw cellulose made, excluding the coal used for soda recovery, but I venture to think it fairly represents what can be done, and is a direct measure of the possibilities in the hands of pulp makers with regard to the economy of coal.

### DISCUSSION.

Mr. A. Smetham said he had been interested personally in the distinctions which Mr. Beveridge drew in regard to the different straws and their value to the paper maker, and that more particularly because in their use for feeding purposes various straws had distinct values. He noticed in the tables by Muller that the percentage of cellulose was found to vary to a very large extent, whereas with Mr. Beveridge's estimates the percentages for his practical purposes by the bisulphite tests for the cellulose were, if not identical, very nearly so, in the straws from the various sources. It had been puzzling him how to account for those differences. Doubtless in paper making a certain quantity of the actual cellulose would be destroyed, partly in bleaching, and it might be for those reasons that the differences existed. He was not aware what process Muller used for the estimation of the cellulose, but taking his figures, and assuming for the moment that Muller had used a process which he (Mr. Smetham) thought was common with nearly all agricultural chemists, viz., that of boiling with two per cent. solution of sulphuric acid, washing with water, then boiling with a two per cent. solution of caustic potash, washing again with water, then with a dilute cold solution of hydrochloric acid, and washing free from acid, then with alcohol and ether, and finally drying. It seemed difficult to believe that the quantity of cellulose, as stated by Mr. Beveridge, would really be above that in the table, the more especially as he noticed that the strength of the caustic soda used by the paper maker was something under one-third per cent. It was true that the digestion went on very much longer in paper making than in the laboratory (for half an hour) with the caustic; in practice, according to Mr. Beveridge's tables, it went on under pressure at a temperature of 307° for four hours, and possibly therefore there might be gradual loss. He imagined that the process in the laboratory would have been quite as drastic as the process of the paper maker, and it was certain that Muller's results, so far as oat straw was concerned, were in accordance with what was found when the straw was used for feeding purposes. The percentage of cellulose in straw depended very largely on the period of growth, and it was possible that the differences between Muller and Mr. Beveridge could be accounted for in that manner. Certain it was that the oat straw was more valuable for feeding purposes than wheat straw. He would be interested if Mr. Beveridge could throw some light upon that difference, and it would also be interesting to him if Mr. Beveridge would sketch in a rough way the process which he used on the laboratory scale for estimating the cellulose by the bisulphite test.

Mr. Bateson remarked that there was a process brought forward to add bicarbonate of soda and precipitate silica. Was this process likely to pay? The table exhibited showed that the percentage of cellulose varied a great deal, according to the quantity of caustic soda added. What was the reason of this variation? With regard to the recovery of potash in the residual liquors, would not the potash accumulate, and was there not a point where it would be taken away advantageously?

Mr. Beveridge said the fact was the laboratory method which he had used for estimating the cellulose was that formulated by Muller, and did not involve the use of caustic potash at all, but was substantially that indicated in the body of his paper—namely, treating the sample first with water, then, after drying, with alcohol and benzol, and finally with successive baths of ammonia and bromine water, an allowance being made for mineral matter in the cellulose residue. It was therefore distinct from the method mentioned by Mr. Smetham, which included digesting the sample in a two per cent. caustic potash solution, whose solvent action was much greater than that of ammonia. It was five years ago since he (Mr. Beveridge) tried Muller's method, and he confessed he was not so well acquainted now with the details as he ought to be. He threw over the process at that time because he found it did not give him a correct idea of the amount of cellulose available for paper making, and, as a manufacturer, preferred the bisulphite method instead. This consisted in digesting the straw for six or seven hours in a bisulphite of soda solution containing about 2·75 per cent. total $SO_2$, about 55 per cent. of which existed in the free state, the other 45 per cent. being combined as monosulphite. The temperature employed corresponded to a steam pressure of 60 or 70 lb.

above atmosphere. The apparatus he used consisted of a strong tube of antimonial lead inserted in a small wrought iron boiler containing water. This boiler, which was heated by gas, acted as a steam jacket. The sample and bisulphite solution were placed within the antimonial lead tube. While managing a large sulphite wood pulp plant on the Thames, where all the pulp boilers were stationary, he had used another and more convenient and reliable method. This consisted in simply placing the sample of straw and the bisulphite solution in a cylindrical leaden dish, sealing it up with the blowpipe excepting a small pinhole in the cover, and placing it inside one of the large wood pulp boilers. The sample was "digested" under the same conditions of time and temperature as the wood within the boilers. In this way he got excellent results. He had varied the percentage of $SO_2$, within certain limits, and had found that the yield of cellulose was not affected by a reasonable excess of $SO_2$ as bisulphite. The percentage of $SO_2$ must not, however, be too high, otherwise he thought hydrocellulose was formed. These results were uniformly lower than the percentages given by Muller, and if the latter were correct, he could not understand why paper makers did not get a higher yield than 40 per cent. air-dry pulp by the most careful manipulation in the factory.

He believed that some substance was included in Muller's percentages of cellulose as given in the table which could not rank as cellulose. The fact that, in the instance quoted by Roth, in which a yield of 50 per cent. air-dry pulp was obtained, 7 cwt. of bleaching powder were required to bleach 1 ton of this pulp plainly showed there was some substance present which required inordinate oxidation. He thought on the whole Muller's results were too high. The percentage of cellulose given by Muller for the oat straw agreed more closely with his own, but that given for wheat and barley was too high according to his experience. Referring to the points raised by Mr. Bateson, the potash could not be allowed to accumulate in the liquors unless the silica was periodically removed. The amount of this silica was so great that where the percentage of soda recovered was anything like 70 per cent. of the amount put into the pulp boilers, after the recovered ash was used twice or thrice, it became practically worthless for further use for digesting. It was obvious, therefore, that the silica must be removed before the potash could be allowed to accumulate to any great extent. The separation of this silica as a practical manufacturing operation was indeed a very difficult process, but if this could be adequately done, the only way, as far as he knew, in which the potash might be utilized was by the method mentioned in the paper, viz., by separating the carbonate of soda from the carbonate of potash by crystallization, and, after neutralizing the mother liquors with sulphuric acid, adding sulphate of alumina to get a potash alum.

## SEWAGE DISPOSAL WORKS, CANTON, OHIO.

By L. E. CHAPIN, member of the Civil Engineers' Club of Cleveland.

THE city of Canton, with a population of 32,000 and an area of 7 square miles, has a storm water system of sewers for the removal of all storm water, and into this system no household wastes of any description are admitted. These storm water sewers discharge into the two branches of the Nimishilla Creek by the most direct and accessible routes.

For the removal of household wastes a separate system of sewers is used, into which no rain water or elevator water is discharged. The general plan of this sanitary system contemplates the sewerage of the entire city by systems of mains, submains and laterals, varying from 6 to 20 in. in diameter, and of vitrified salt glazed sewer pipe. The minimum grades range from 1 ft. in 100 for the 6 in. laterals to about 0·2 ft. in 100 for the 20 in. main sewers.

All laterals are provided at their upper ends with automatic flushing tanks, and a frequent and regular cleansing of all sewers is thus insured. The flush tanks are in the main equipped with the Rhodes-Williams automatic siphon. Some sixty siphons of this pattern are in use, as well as eight Field-Waring siphons and one Rosewater siphon.

These siphons are so supplied as to flush at intervals of from eight to twenty-four hours, depending upon the number of house connections made with each individual sewer. The water discharged at each operation of the siphon varies from about 250 gallons in the 5 in. siphon to about 350 gallons in the 6 in. siphon.

In the maintenance of a sanitary system embracing some seventeen miles of sewers, no trouble has so far been experienced in keeping the entire sewer system, both laterals and mains, clean and free from any adhering organic matter or deposits by the use of this system of flushing.

The seventeen miles of sewers are entirely in the central part of the city, known as Sewer District No. 3. To complete the plan for the entire sewering of the city involves the future construction of sanitary sewers in Sewer Districts Nos. 1 and 2. The mains from these districts are designed to discharge into the main sewer of District No. 3, at the head of what is known as the trunk sewer, and provision is thus made for the removal of all organic wastes through the trunk sewer to the City Sewer Farm, located on the main branch of the Nimishilla Creek, two miles south of the city and outside the city limits.

The sewer farm, embracing 28 acres of land, was originally purchased as land for the outlet, and it was intended that on this land some method of sewage purification should be perfected and carried into operation. Of these 28 acres, however, only about 13 are available for purification by land treatment, the balance being low bottom land annually flooded by the spring freshets of the stream.

### METHODS OF PURIFICATION.

The subject of sewage purification was early brought to the attention of the city authorities by the complaints made by riparian owners below the outfall of the trunk sewer. An investigation of the available methods of purification developed the fact that the ground owned by the city, as well as all other land in the vicinity, was of a formation poorly adapted for purification by broad irrigation or intermittent filtration. The area of land requisite to provide for future requirements by these methods of purification could not be had except at great expense, it being then considered that for broad irrigation there would be required some 300 acres of land, the first cost of which, including the preparation of 120 acres to adapt it for the purpose, as well as the expense of a pumping plant, buildings and force main, would result in a total expense of $155,123, from which the annual expense was estimated as follows:

| | |
|---|---|
| Interest on $155,123 at 4 per cent.... | $6,244 96 |
| Cost of pumping per annum..... | 1,942 40 |
| Total expense per annum..... | $8,187 36 |

For intermittent filtration there would be required at least 50 acres of land, the preparation of 13 acres for present requirements by sloping and underdraining, a pumping plant and buildings, and a force main for lifting the sewage. The estimated total cost of all this was $45,482, and the annual expense, including interest and cost of pumping and operation, $3,861.30.

The tract owned was, however, so located that the sewage could be brought to it by gravity, and the expense of pumping was thus obviated. Inasmuch as a large area of land would be required for broad irrigation, and as it was almost impossible to obtain for intermittent filtration a suitable tract of ground within reasonable distance, it was deemed best to adopt the method of chemical purification for the Canton city sewage, the works to be built on the city sewage farm and the sewage brought to it by gravity.

For the purpose of arriving at the probable cost of such works, a plan, report and estimate of cost were had from Samuel M. Gray, of Providence, Rhode Island. The estimated cost of the works complete was about $38,000.

Before proceeding with the construction of the works a special committee of the city council was appointed to visit towns in the Eastern States where purification works had been constructed, and report the result of their investigation to the council for further consideration.

This committee visited the several prominent purification plants then in operation in Massachusetts, New York and New Jersey, and reported favorably upon the method of chemical precipitation recommended by Mr. Gray as being the best and most practicable, and recommended that immediate steps be taken to carry out his plans.

The committee, convinced of the ultimate success of the works, and believing that the effluent reaching the creek would be in no manner objectionable to the owners and residents of the lower creek valley, suggested certain modifications in the design of the works. Upon the adoption of this report the board of sewer commissioners instructed the city engineer to prepare an amended plan for chemical purification works in accordance with the ideas suggested by the visits of the special committee in the East; and, after several plans had been prepared and carefully studied, a plan of precipitation works somewhat similar to that built by the city of Worcester, Mass., was adopted, specifications prepared and proposals ordered.

For funds to carry on the work the city of Canton had authority, previously conferred by act of the State Legislature, to issue $25,000 of sewage disposal bonds; and within this amount it was deemed advisable to limit, so far as could be, the cost of the works complete and in working order.

Specifications were prepared and bids received, and contracts were awarded separately for the grading, for the construction of the inlet sewer, masonry, precipitation tanks and effluent sewer, for the building and for the machinery and appurtenances.

Ground was broken in July, 1892, and the greater part of the brick masonry and connecting sewers was built during the same fall and the early winter. The building was erected during the winter and the machinery and appurtenances in the spring. The entire plant was in running order by May 15, 1893, and the total cost was $26,483.76.

### THE PLANT.

The plant is contained in a heavy frame building on a brick foundation, and comprises a boiler and pump room, 28 by 30 ft., lined with brick; a chemical mixing and press room, 30 by 40 ft.; and a chemical store and slaking room, 30 by 40 ft., located above the mixing room.

The four precipitating tanks are each 50 by 96 ft. in plan. When filled they have an average depth of 4·75 ft.; the sewage being 3 ft. 10 in. deep in the shallowest and 5 ft. 9 in. in the deepest parts. The capacity of each tank is 171,100 gallons.

The sludge is lifted by a horizontal duplex Voisard sludge pump having steam cylinders 7½ in. in diameter, with 5 in. plungers and 10 in. stroke. The suction pipe connections are so arranged as to take either sludge from the sludge cistern or clear water from the clear water well, and the discharge connections are such that the sludge may be forced into the filter press or through a line of 2½ in. pipe outside of the building to a sludge gravel bed, or clear water pumped from the clear water well to an overhead storage tank within the building.

The feed pump is a duplex, 4½ by 3 by 5, so arranged that it can be used either for boiler feeding, for filling the overhead supply tank, or for pumping water under pressure for cleansing purposes about the building and for washing down the sides of the tanks after the sludge is removed.

Steam is generated in a horizontal tubular boiler, 54 in. in diameter and 12 ft. long, placed in a substantial brick setting with full arch front. The smokestack is of plate iron and 53 ft. in height.

The chemical mixers are of wood and elliptical in form, with diameters of 5 and 9 ft. and 7 ft. high. They are operated by an automatic vertical engine.

The filter press is a sixty-section chamber Bonnot press, each chamber being 29 in. in diameter and equipped with rubber gaskets to obviate the tearing of the filter cloths. The press has a traveling head with a hand-tightening gear and quick opening arrangement, with the necessary relief valves, blow-off connections and air chamber.

Within the sludge cistern is located a No. 5 pulsometer pump, the connections of which are so arranged that it can be operated from the boiler room, lifting the sludge from the cistern and discharging it either into an open tank located outside of the pumping room or through a line of 2½ inch pipe onto a sludge gravel bed. This pump is designed to be used as an auxiliary for lifting the sludge at times when the sludge forcing pump is in need of repairs.

In case the suction lift without foot valve should at any time prove hard to maintain, the sludge can be supplied by gravity from the open tank to the suction chambers of the sludge forcing pump.

Water for all steam and mixing purposes is drawn from the effluent channel, and is pumped into an overhead storage tank holding 2,200 gallons. From this tank it is drawn off as required.

### TREATMENT.

The sewage is diverted from the main sewer into the inlet sewer at a manhole, just above the city farm. The inlet sewer enters the building at one end under the boiler room floor, and there enlarges into a screening chamber provided with gates and screens for the removal of obstructive matters. Thence it passes through an inlet channel 4 ft. in width to the four tanks located outside of the building.

The lower end of this inlet channel connects with a double circulating channel located midway between the four precipitating tanks, two of which are placed on each side of the channel.

At the point where the sewage enters the building it receives a charge of milk of lime from the lime mixer, and where it leaves the building a solution of sulphate of alumina is added. The sewage, then passing down the inlet channel, is agitated by baffle boards within the channel. This insures a thorough mixture of the precipitating agents with the crude sewage before the latter enters the precipitating tanks. On reaching the precipitating tanks the sewage so charged enters the first tank and passes through it to the further end. It is then deflected back and re-enters the circulating channel, from which it enters the second tank. Thence, by the same method of circulation, it passes into and through the third and fourth tanks to its exit over the aerating steps of the effluent chamber, and thence into and through the effluent sewer to the point of outfall in the Nimishilla Creek.

The chemicals used, lime and sulphate of alumina, are delivered by wagon into the second story of the mixing room, and are there stored in their respective bins. The proper charges of lime are weighed out at regular intervals into a slaking tank located on this floor, and, after being slaked with a large surplus of water, are passed down into the lime mixer on the first floor, while the sulphate of alumina, weighed out in the requisite amounts, is dumped directly into the top of the chemical mixer, which is also on the first floor. Sufficient water is added to both the lime and alumina solution to facilitate their easy and uniform discharge into the crude sewage.

These lime and chemical mixers, as already stated, are elliptical in plan, having diameters of 5 and 9 ft. and 7 ft. in height. Each mixer has two vertical shafts carrying beater arms and revolving at the rate of about 20 revolutions per minute for the purpose of maintaining a homogeneous mixture. The agitating power is obtained from a 16 horse power vertical engine, which drives the mixers by belting. From these mixers the solutions are discharged through 2 in. pipes controlled by gate valves, so that the quantities discharged are easily regulated.

The precipitation process is such that approximately one-half of the suspended matter taken out is deposited in the first tank and about one-fourth in the second tank, while the balance is equally distributed between the third and fourth tanks. The sludge is removed three times a week from tank No. 1, twice a week from tank No. 2, every five days from tank No. 3 and once a week from tank No. 4. This method of sludge removal gives, as shown by experiment, a uniform daily amount of sludge for pressing and the best results in precipitation.

To remove the sludge from the bottom of each tank the tank to be cleansed is cut out from circulation, the sewage then passing by it and into the other three tanks in rotation. After standing for some two hours, the supernatant water from the tank so cut out is decanted by means of a floating skimmer pipe into a clear water sewer lying beneath the circulating channel and discharging under the lower steps of the effluent chamber and thence passes into the effluent sewer.

When the floating skimmer pipe reaches the accumulated sludge in the bottom, the sludge is raised to the surface. Then by means of a 12 in. gate valve, the accumulated sludge is drawn off into a sludge sewer located under the circulating channel and discharging into a sludge cistern placed beyond the tanks and just outside of the pumping room.

From this cistern the sludge is lifted by the suction of a duplex plunger pump with ball valves, and is forced into a sectional filter press under a pressure of about 100 pounds per square inch. From this press the exuded water passes out through the filter cloths and into a gutter beneath and thence through a drain to the inlet sewer, the solid matters being retained within the press in the form of cakes, and when the press is emptied the cakes fall into a car below. This car, when full, is run out of the building on a track, which passes across the tanks by a bridge to the sludge cake dumping ground.

About 8 grains of lime and 1·6 grains of sulphate of alumina have been used per gallon of sewage treated. Owing to the large capacity of the precipitating tanks, these proportions give a very satisfactory effluent. As the other districts come to be sewered and the quantity of sewage to be treated increases, a larger amount of chemicals can be added, and thus an effluent can be maintained such as will satisfy all present and future requirements.

Should the creek water be used as a public water supply, the effluent from the works can be further treated, without pumping, by intermittent filtration on the city's lands adjoining the works on the west side. The absence of any suspended matters in the present effluent would enable a comparatively large

* From the *Journal of the Association of Engineering Societies*. Read December 12, 1893.

amount of effluent water per acre to be applied to the land prepared for intermittent filtration.

The total amount of sewage treated daily averages 880,000 gallons, from which are obtained, approximately, four tons of sludge cake per day.

The raw sludge, as it is drawn into the sludge cistern, contains, approximately, 95 per cent. of water, and the cake obtained from filter pressing contains, approximately, 58 per cent. of moisture. About four presses of sludge per day are obtained, each press making 60 cakes of an average weight of 33⅓ pounds.

Thus far no attempt has been made to sell the sludge cake, but no difficulty is found in having the cake promptly removed from the dumping ground by farmers desiring it for fertilizer.

The average time consumed in running out a press of sludge cake is, approximately, two hours, which includes the filling of the press, the emptying and the locking up of the press ready for refilling; but the operation has been performed in 55 minutes. The rapidity of operating depends upon the texture of the filter cloths, a closely woven jute material of about 15 threads to the inch being found most satisfactory, although not as durable as a canvas having 40 threads to the inch, such as is used at present.

The life of canvas sacks approximates two months, or 200 presses, while the life of jute sacks runs somewhat less, depending upon the character of the sludge and largely upon the diameter of the central openings through the filter chambers, the larger openings giving less resistance to filtration and much better service.

The use of a duplex pump in filling the filter press has so far proved highly satisfactory. The pump, being equipped with ball valves of hard rubber, passes freely large amounts of thick and stringy matter without the slightest choking, and responds promptly to the varying requirements of the press for sludge.

The monthly expenses for maintenance are as follows:

| | Per month. |
|---|---|
| One engineer in charge of the works | $60 00 |
| One helper | 40 00 |
| One night engineer and watchman | 40 00 |
| Coal, 20 tons | 31 00 |
| Lime, 15 tons | 42 90 |
| Sulphate of alumina, 3 tons | 60 00 |
| Oil and waste | 8 00 |
| Filter cloths | 10 00 |
| Miscellaneous | 3 10 |
| Total per month | $295 00 |
| " " year | 3,540 00 |

This amounts to 23 6 cents *per capita* per year with a population of 15,000 persons in the district connected with the sewers, or $11.19 per million gallons of sewage treated.

For an increase in the amount of sewage treated the cost for attendance, coal and other supplies would remain the same, and the additional cost would practically be only that of the additional lime and alumina required.

During the winter months, and at times of freshets and high water, only so much sewage will be passed through the precipitating tanks as will suffice to protect them from frost, chemical treatment will be entirely omitted, and only sufficient help will be retained at the works to properly care for them. In this manner the annual expense will be reduced to a figure materially below that named.

The lowest observed temperature of the sewage at the outfall in the coldest weather of the winter of 1892–93 was 46° Fah., and at the same time the city water supply was at a temperature of 34°.

The lowest temperatures observed during the recent cold weather, when the temperature of the external air was 16° Fah., was 50° for the sewage at the mouth of the inlet sewer, 48° where it enters tank No. 1, 49° at the farther end of tank No. 1, 47° in each end of tank No. 2 and in tank No. 3, 46° in tank No. 4, and 45° in the effluent water at the foot of the aerating steps, showing a total loss of temperature of 5° in the passage of the sewage through the tanks.

On the basis of the same decrease in temperature for the colder weather in the winter, when the temperature of the external air stands below zero, it is unlikely that the temperature of the effluent for continuous circulation will fall below 41° or 40° Fah.

Several analyses have been made of the sewage and of the effluent, but the conditions under which the samples were taken were such that the results obtained by the analyses thus far made do not show the true working of the plant, for the samples have been taken within too limited a period of time, and too long a time was allowed to intervene between the collection of the samples and their analysis.

Generally speaking, the analyses show that, using lime alone, and at the rate of 1,100 pounds per million gallons of sewage, 59 per cent. of the organic matter contained was removed by the process of treatment. No analysis of the effluent has been made since the use of sulphate of alumina, in addition to the lime, was adopted.

The indications, so far as one can judge from an inspection of the effluent, are that by the addition of 200 pounds of sulphate of alumina per day a much higher degree of purification is attained.

The analysis of the lime used shows the following composition.

| | Per cent. |
|---|---|
| Calcium oxide | 84·7 |
| Magnesium oxide | 1·5 |
| Ferric oxide | 5·8 |
| Moisture, carbonic acid and undetermined | 8·0 |
| Total | 100·0 |
| Lime, soluble in water | 82·5 |

This is a local lime, costing 10 cents per bushel of 70 pounds delivered in the bin at the works.

The sulphate of alumina, so far used, is represented as containing insoluble matter 10 per cent., and sulphate of alumina 44 per cent. It costs, in a pulverized condition, about $20 per ton in car load lots delivered at the works.

Investigations are now in progress to determine the suitability of other grades of sulphate of alumina, with the idea of obtaining, at the lowest cost, that most suitable for the process.

The operation of the works has continued to be highly satisfactory to the citizens of Canton and to the riparian owners of the lower creek valley, and no odors of any nature are discernible at any time about the plant. The authorities are well satisfied with the results of chemical precipitation for the disposal of house sewage.

## TUBERCULIN AND BOVINE TUBERCULOSIS.

By E. A. DE SCHWEINITZ, Ph.D., Biochemic Laboratory, Bureau of Animal Industry, Washington, D. C.

IN the SCIENTIFIC AMERICAN SUPPLEMENT for April 28, 1894, Mr. H. G. Wolcott, New York State Commissioner of Health, has an article on bovine tuberculosis, in which he makes the statement that the department in Washington has the formula for the manufacture of tuberculin, but that this and the imported tuberculin do not give the same febrile reaction. This statement is misleading, and deserves correction, because it is not warranted by facts.

About three years ago I began the preparation of tuberculin for use in diagnosing disease in cattle, following in general the method as indicated by Koch in his early articles on the subject, modified by some slight changes which were advantageous to the work. Before making any extensive use of this tuberculin, comparative tests were made with the Koch imported article, with results which showed the tuberculin as manufactured here to be equally reliable. These experiments were carefully conducted, and the comparative results upon a herd in which all the animals were eventually killed will shortly be published by the bureau. All the tuberculin prepared in this bureau has been either made by me personally or under my direct supervision, and none has been sent out for use from this laboratory unless its strength and reliability had been first tested upon tuberculous guinea pigs and tuberculous cattle.

At the request of the State Board of Health of New York, two small lots of tuberculin of known reliability were forwarded to them for use. What disposition was made of this material I do not know, as the board failed to make any report upon its use. When the tuberculin left my hands it was reliable in every way. During the three months beginning January 1, 1894, tuberculin has been sent to twenty-four States, in quantities sufficient to test about two thousand five hundred animals. Some of the parties have used the Koch tuberculin at the same time, and in no instance have any unsatisfactory reports reached this office. As Mr. Wolcott states, tuberculin can be reliable in *skilled* hands only, which means, not only the hands of one who has used tuberculin a number of times, but one who is thoroughly familiar with the literature on the subject. This is considerable and covers a number of experiments, both in this country and abroad, which indicate many idiosyncrasies, both in animals and reactions.

The earliest results with tuberculin showed that there was always a difference in the rise of temperature between the first and second injections on the same animal, that if the first temperature was high, the second would often be lower by several degrees, or in some instances the second injection would give no reaction. Again it would occasionally happen that the first injection would cause only a slight rise of temperature, while the second would give a very marked rise. These results were irrespective of the tuberculin. The interval of time between the first and second injection with the tuberculin, in order that the second injection can be considered at all reliable, should be at least one month, and even after this time the second injection will occasionally be unreliable.

In certain cases, too, the tuberculin possesses some undoubted curative properties, and these and other facts, as well as the idiosyncrasies of the animals, must be taken into account in drawing conclusions.

The value of tuberculin as a diagnostic agent is undoubted, and by its use it will be possible eventually, if not to entirely eradicate, at any rate to control and limit the disease among cattle, and thus indirectly in man.

The active principle of tuberculin is sometimes incorrectly called a ptomaine, and statements are often made that nothing is known of its true nature. Ptomaines is a name given to a class of substances that are like the vegetable alkaloids in their constitution and many of their properties, and this name was first used to indicate the alkaloidal substances that were derived from the putrefaction of animal matter. A number of different germs produce alkaloidal substances and in that sense ptomaines, but these are not the only products.

The active principle of tuberculin, however, has been proved to be not a ptomaine, but a substance belonging to the albuminoids, probably the nucleo-albumens. The same appears to be true for the active principle that is produced by the glanders bacillus, the diphtheria, tetanus, hog cholera, swine plague and other germs. Our knowledge at present does not give us a clear insight into the nature of these albuminoids, but is sufficient to exclude the substances from the ptomaines proper, unless the word is used to signify bacterial poisons in general.

The Bureau of Animal Industry, under the direction of Dr. A. E. Salmon, furnishes to State boards of health and experiment stations a tuberculin reliable in every respect.

By its aid national legislation and State co-operation can do much to rid the country of one of the most dangerous of diseases for animals and man.

## TRIKRESOL.

UNDER this name a purified mixture of ortho-, meta-, and paracresol has been introduced for surgical purposes. It is a clear, colorless liquid, having an odor like creosote, and boiling between 185° and 205°. The specific gravity is from 1·042 to 1·049 at 20° C., and it is said to be almost, if not entirely, free from phenol. The purification of this product from neutral hydrocarbons has been carried out so that the purified product will dissolve in water to the extent of from 2·2 to 2·5 per cent., which is amply sufficient for its application in surgical practice, for which purpose a solution containing from 0·5 to 1·0 per cent. is strong enough, on account of the great disinfecting power of the cresols. By means of this purification it is thought that the necessity for adding emulsifying agents to cresol in order to obtain sufficiently strong solutions will be done away with. Gruber's determinations of the solubility of cresols in water gave the following results (*Archiv. f. Hyg.*, 17):

| | Per cent. |
|---|---|
| Orthocresol | 2·50 |
| Metacresol | 0·53 |
| Paracresol | 1·80 |
| Mixed cresols from toluidine | 2·20 |
| " " " tar oil | 2·55 |


THE

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## THE AIR SHIP DIVISION OF THE GERMAN ARMY.

IT is very seldom that the general public knows anything about the air ship division of the German army, which is continuously working and experimenting on one corner of the Tempelhof Field, whence ascensions are made. Even Berliners rarely have an opportunity of seeing any of the maneuvers of this department, with its wagons, well drilled soldiers and peculiar apparatus.

But one thing is certain, and that is that in case of war it would be found that Germany was not behind the other nations in her inventions and arrangements. The armies of the Triple Alliance have adopted a uniform system for filling and transporting balloons, the Majert-Richter system being now used by Germany,

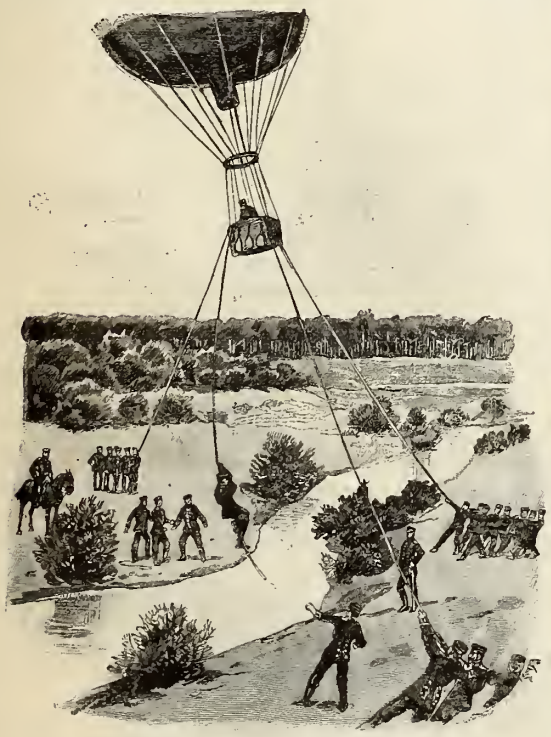


FIG. 1.—CROSSING A STREAM WITH A BALLOON.

Austria and Italy, while the other European states employ the Yong system.

The balloons are filled with hydrogen gas, which is manufactured by the department in a little building on the grounds; but in case of a campaign a whole gas-making plant could not be carried from place to place, nor has this been possible during maneuvers. Therefore, the gas necessary for filling the balloons must be carried in steel cylinders, which look almost exactly like those used for transporting liquid carbonic acid gas. These steel cylinders are about 8 feet long and have a diameter of about 5 inches; the gas in them is under a pressure of from 100 to 120 atmospheres.

Engraving No. 2 shows the operation of filling a balloon during maneuvers. The wagons which carry the steel cylinders have formed a circle around the balloon to be filled, and one cylinder after another is connected with its interior by means of a hose. We see the balloon already half filled, and as it is being filled from five wagons at once, scarcely an hour will be required for the operation. During maneuvers and campaigns captive balloons will generally be used, recourse being

FIG. 5.—DANGEROUS DESCENT.

had to free balloons only in cases of abandoning a stronghold or a blockaded station. The newspaper reports keep the public well informed in regard to the ascensions of free balloons, and our engraving No. 5 gives a vivid idea of some of the dangers that may be incurred when the descent cannot be managed as desired on account of storm, the closing in of night or other unfavorable conditions. The balloon shown here has descended in a pine wood and become fast among the tree tops. One man is letting himself down by the anchor rope, so as to go for assistance and also to make an anchorage.

Captive balloons are generally used in the open field also. In pleasant weather a balloon can ascend to a height of more than 1,900 feet, and from this height fine observations can be made. With good glasses the uniforms of advancing troops can be discerned when they are still at a distance of 9 miles. Reports are sent down from a captive balloon by a telephone, the wire of which is concealed in the anchor rope. Sketches and written information are sent down in tin boxes also by means of the rope. A balloon can be held by a single strong but not very thick cable,

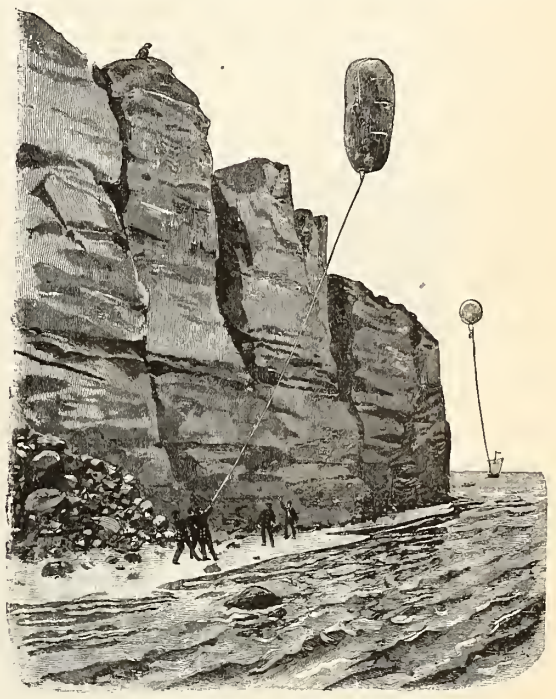


FIG. 4.—TRANSPORTING GAS IN BALLOONS ON THE COAST.

but a special wagon with a windlass must be provided for drawing the balloon down at a regular, even rate, the cable being wound on the drum. If the balloon mounts only to a height of from 300 feet to 600 feet—and when there is wind it is scarcely possible to reach a greater height—the wagon with the windlass is unnecessary, and in that case the balloon is provided with four ropes that are held by men. By means of these four ropes the balloon can be moved here and there over the field, the men marching about with the ropes.

This moving of the balloon is very important in case of an emergency, for even when at a height of 9,800 feet a balloon is within reach of the shots of the infantry, and the fire of the artillery can reach it from a distance of three miles. The falling of a balloon (this is

FIG. 2.—FILLING A BALLOON DURING MANEUVERS.

FIG. 3.—A BALLOON SUNKEN IN A PIT.

not very dangerous, as the balloon sinks slowly) can only be prevented by continuously changing its position. It is interesting to see how the men manage to get over obstacles in moving the balloon from place to place. Our engraving No. 1 shows the men crossing a stream. One man after the other swings himself across on one of the ropes, and then throws the rope back to the next man, until all of the men belonging to one rope have crossed, then those holding the next rope follow, etc. When bridges, especially railroad bridges, have to be crossed during the march, the same system is followed. They are passed by means of the so-called "split rope."

Engraving No. 3 shows a captive balloon that has been drawn down to the ground during maneuvers and is to be sent up again. A deep hole has been dug and more than half of the balloon let into the damp earth, so that the coolness will condense the gas and its escape through the fabric will decrease. The next morning it will only be necessary to refill the balloon from the steel cylinders, and it will be ready for ascension. In places that cannot be reached by the wagons with the cylinders, for instance, on the coasts (experiments with captive balloons have also been made on warships), or in the mountains, the cylinders are emptied into little balloons, as shown in engraving No. 4, which are then transported to the large balloon into which their contents are emptied.—*Illustrirte Zeitung.*

## KRUPP ORDNANCE.

THE ordnance exhibit of Essen, at Chicago, says *Engineering*, was certainly the most complete and splendid that has ever been seen in the United States of America; probably it was the most important ever made at an International Exposition by any single manufacturer of ordnance. It was contained in a pavilion erected near the east front of the Agricultural building, and quite remote from the Transportation exhibits building, to which it belonged. This pavilion was about 200 ft. long, 42 ft. high, and 82 ft. wide. It was designed and constructed in Germany, and shipped to Chicago complete for erection. The contents comprised a large series of ordnance, from the great 120 ton gun to the smallest calibers for mountain service; a large display of projectiles, a series of armor plates, and a great number of rolled and pressed objects in steel, prominent among which were the frames and trucks of rolling stock referred to elsewhere. The most conspicuous object in the ordnance collection was the 120 ton gun, which presented a monumental appearance in the center of the hall.

### THE 42 CENTIMETER (16·54 IN.) GUN.

The 42 centimeter gun was built for coast defense service, but it is more likely to remain as a monument to the wonderful producing power of Essen than to come into active use as a weapon of offense. A few particulars of this magnificent piece of ordnance may be added. The breech mechanism is of the standard type, with rounded sliding wedge block, and the charge is fired by a friction fuse. The following are some of the chief dimensions:

| | |
|---|---|
| Caliber | 16·54 in. |
| Length of barrel | 45·93 ft. |
| Length of bore | 41·66 ft. |
| Number of grooves | 120 |
| Weight of barrel with breech | 120·46 tons |

Four classes of ammunition were made to be fired from this gun: cast iron shells, steel shells, armor-piercing projectiles, and steel shrapnel; the weights of these varied from 2204 lb. to 2513 lb. The weights of the bursting charges of the various projectiles were as follows:

| | |
|---|---|
| Cast iron shell | 72·75 lb. and 88·18 lb. |
| Steel shell | 119·04 lb. and 143·29 lb. |
| Armor-piercing shell | 22·04 lb. and 27·55 lb. |
| Shrapnel | 22·04 lb. and 25·13 lb. |
| Number of balls in shrapnel | 3000 and 4000 |
| Weight of each ball | 3·52 oz. |

As stated above, there have been 16 rounds fired from this gun, and the following results were obtained from the experiments made:

| | |
|---|---|
| Weight of projectile | 2204 lb. |
| Powder charge | 903·8 lb. |
| Initial velocity (feet per second) | 1981 |
| Total striking energy | 60,002 foot tons. |
| Energy per kilogramme (2·2 lb.) of barrel | 1099·42 foot pounds. |
| Maximum range with 10·5 deg. elevation | 9680 yards. |

Perforating power of steel shell on wrought iron plate:

| | |
|---|---|
| At muzzle | 3·53 ft. |
| At 3281 ft. | 3·26 ft. |
| At 6562 ft. | 3·01 ft. |

At the Exposition the gun was mounted on a front pivoting carriage, the rear part of the mounting being supported on four rollers traversing on a curved roller path; this formed the lower part of the mount. The gun itself was supported on an upper carriage, which could be moved to and fro on the inclined slides of the pivoted mount. A toothed quadrant is attached to the side of the gun, and it is raised and lowered by a train of handworked gearing engaging in this quadrant. Horizontal training is effected by a pitched chain and gearing operating on the back of the underframe. The recoil is taken up by hydraulic brakes, the piston rods of which are attached to a cross frame on the upper carriage, the brake cylinders themselves being on the lower carriage. The gun and upper carriage are run out by means of a chain and windlass.

The first two columns of figures below refer to the steel armor-piercing shell, fired with brown prismatic powder (initial velocity, 2021 ft.) and the smokeless powder (2234 ft.) against a wrought iron plate; the last two rows of figures refer to shell fired against a steel plate with similar velocities:

| | In. | In. | In. | In. |
|---|---|---|---|---|
| At the muzzle | 39·09 | 45·66 | 25·75 | 29·69 |
| At 1094 yards | 35·71 | 45·58 | 23·62 | 27·29 |
| At 2187 yards | 32·48 | 38·03 | 21·62 | 25·08 |

### THE 28 CENTIMETER (11·02 IN.) GUN.

The 28 centimeter (11·02 in.) gun that was exhibited is also intended for coast defense, and is an admirable example of Krupp's recent practice. It is of the 1889 pattern, and is 40 calibers in length. The following are some of the leading particulars:

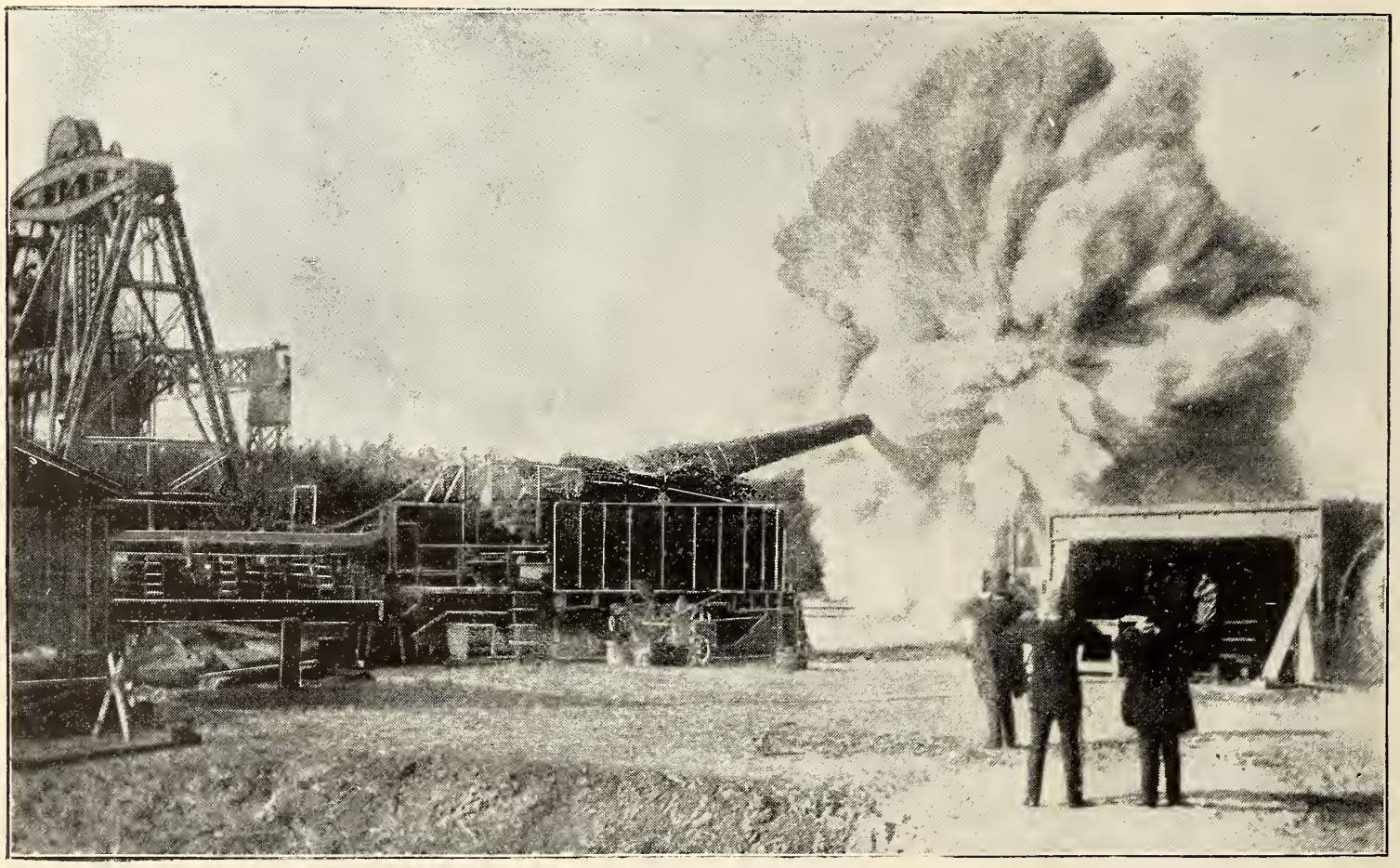
| | |
|---|---|
| Caliber | 11·02 in. |
| Length of barrel | 36·75 ft. |
| Length of bore | 33·99 ft. |
| Number of grooves | 84 |
| Weight of barrel and breech | 42·62 tons. |

The weight of the loaded projectile fired from this gun is 760·59 lb., and the following are particulars of the four kinds of shell employed:

| | |
|---|---|
| Cast iron shell, bursting charge | 25·35 lb. |
| Steel shell, bursting charge | 44·09 lb. |
| Armor-piercing shell, bursting charge | 7·94 lb. |
| Steel shrapnel, bursting charge | 7·61 lb. |
| Number of balls in shrapnel | 1030 |
| Weight of each ball | 0·22 lb. |

Firing experiments made with this gun gave results which may be summarized as follows:

| | |
|---|---|
| Weight of projectile | 760·59 lb. |
| Weight of charge (prismatic powder) | 352·74 lb. |
| Initial velocity | 2067 ft. |
| Total energy at muzzle | 22,536 foot tons. |
| Total energy at 1094 yards | 19,633 foot tons. |
| Total energy at 2187 yards | 16,145 foot tons. |
| Energy per kilogramme weight of barrel | 0·52 foot tou. |
| Maximum elevation | 45 deg. |
| Range at maximum elevation | 22,200 yards. |



FIRING THE ONE HUNDRED AND TWENTY TON GUN.

As already stated, the gun is interesting as a specimen of magnificent workmanship, rather than as an example of efficient ordnance or of the modern practice at Essen.

### THE 30 CENTIMETER (12·01 IN.) GUN.

The following are some of the particulars of this gun:

| | |
|---|---|
| Caliber | 12·01 in. |
| Length of barrel | 35 ft. 1·2 in. |
| Length of bore | 32 ft. 0·6 in. |
| Number of grooves in rifling | 68 |
| Weight of barrel and breech mechanism | 61·46 tons. |
| Maximum elevation | 13 deg. |
| Maximum depression | 5 deg. |
| Weight of carriage | 53·15 tons. |
| Weight of shield | 11·81 tons. |

Four different classes of projectiles are fired from this gun, and there are two types of each projectile, the heavier weighing 1003 lb., and the lighter 725·3 lb.

| | |
|---|---|
| Cast iron shells, bursting charge | 35·27 lb. and 29·76 lb. |
| Steel shells, bursting charge | 59·53 lb. and 44·09 lb. |
| Armor-piercing shells, bursting charge | 10·58 lb. and 9·7 lb. |
| Steel shrapnel, bursting charge | 10·3 lb and 7·25 lb. |
| Number of balls in shrapnel | 1360 |
| Weight of each ball | 0·22 lb. |

Some of the ballistic data of this gun are given below:

| | |
|---|---|
| 1. Weight of projectile | 1003·9 lb. |
| Powder charge, brown prismatic | 429·89 lb. |
| Initial velocity | 2021 ft. |
| Total energy | 28,415 foot tons. |
| Energy per kilo. of weight of gun | 1019·13 foot pounds. |
| Maximum range, with elevation of 13 deg. | 10,827 yards. |
| 2. Weight of projectile | 1003 lb. |
| Powder charge, smokeless cube | 227·07 lb. |
| Initial velocity | 2234 ft. |
| Total energy | 34,728 foot tons. |
| Energy per kilo. of gun | 1245·52 foot pounds. |
| Maximum range of elevation 13 deg. | 11,975 yards. |
| Penetrating power of armor-piercing shell striking at right angles an iron plate at muzzle | 39·09 in. |

Under the above conditions, the penetrating power of the armor-piercing shell in a wrought iron plate is as follows:

| | |
|---|---|
| At the muzzle | 34 in. |
| At 1094 yards | 30·74 in. |
| At 2187 yards | 27·8 in. |

This gun, which was finished only in 1892, is provided with a vertically rising breech block. Although specially designed for coast defense service, it can, with a modified arrangement of the ammunition hoist, be employed for naval service. The mounting is peculiar in affording a very great range of elevation—from plus 45 deg. to minus 5 deg. The mounting is carried on a turntable placed on a live ring of steel balls, and the under carriage is secured to this table; upon this are placed the slides, which in their turn support the upper carriage. The slide is carried at its forward end on journals, and in the center by a cross frame, to which is connected the plunger of a hydraulic cylinder; by raising and lowering this plunger the desired elevation is given to the gun, which is lifted together with the slides and upper carriage. The brake cylinders are placed one on each side of the slides; they are connected with the upper carriage by means of projections on the underside of the latter to which the ends of the brake piston rods are attached. The loading device is operated by hydraulic power, which, as well as the mechanism for working the breech, is controlled from a platform on the turntable. The gun and mounting are protected by a domed turret, also carried by the turntable.

The weight of the shield is 23·62 tons, and of the carriage 59·05 tons.

### THE 24 CENTIMETER (9·45) IN. GUN.

The next was, perhaps, the most interesting gun of the series. This was the 24 centimeter (9·45 in.) gun,

40 calibers in length, and built on the 1886 pattern; the breech mechanism is of the standard Krupp type. The following are some of the leading particulars of this gun:

| | |
|---|---|
| Caliber | 9·45 in. |
| Length of barrel | 31 ft. 6·13 in. |
| Length of bore | 29 ft. 1·75 in. |
| Number of grooves | 56 |
| Weight of barrel with breech mechanism | 30·51 tons. |

The ammunition fired from this gun is similar in character to that used in the other guns shown, the weights being 353 lb. and 474 lb. The bursting charges of the different shells are as follows:

| | |
|---|---|
| Cast iron shell | 15 lb. and 11·68 lb. |
| Steel shell | 26·4 lb. and 21·16 lb. |
| Armor-piercing shells | No bursting charge |
| Steel shrapnel | 4·75 lb. and 3·53 lb. |
| Number of balls in shrapnel | 650 and 217 |
| Weight of each ball | 3·52 oz. and 10·58 oz. |
| Powder charge—prismatic | 254 lb. |
| Powder charge—smokeless | 92·7 lb. |

This gun is remarkable as having given the longest range recorded by any trials, with a projectile of the weight specified. During some firing trials at Meppen, carried out in the presence of the German Emperor, on April 28, 1892, a range of 22,120 yards was obtained (over 12½ miles). The elevation on this occasion was 44°; the duration of flight of the shot 70·2 seconds; and the height of trajectory, 21,456 ft. On the walls of the Krupp pavilion was shown a diagram of this famous round, illustrating the line of trajectory referred to the height of Mont Blanc, and shows that if the gun had been placed at Pre St. Didier in the Alps, and directed at Mont Blanc with an elevation of 44°, the shot would have fallen in the vicinity of Chamounix, after having passed 5675 ft. over the summit of Mont Blanc, which is 15,781 ft. above the level at which the gun would have been fired.

The following are some of the results obtained with firing trials of the 24 centimeter gun:

| | | |
|---|---|---|
| 1. | Weight of projectile | 352·7 lb. |
| | Nature of powder | Brown prismatic |
| | Weight of charge | 253·53 lb. |
| | Initial velocity | 2510 ft. |
| | Nature of powder | Smokeless cube |
| | Weight of charge | 2623 lb. |
| 2. | Weight of projectile | 473·97 lb. |
| | Nature of powder | Brown prismatic |
| | Weight of charge | 253·53 lb. |
| | Initial velocity | 2100 ft. |
| | Total energy | 14,482 foot tons |
| | Energy per kilogramme of gun | 0·467 foot ton |
| | Maximum range elevation 25° | 15,092 yards |
| | Maximum range, elevation 44° | 21,872 yards |
| 3. | Nature of powder | Smokeless cube |
| | Weight of charge | 92·59 lb. |
| | Initial velocity | 2300 ft. |
| | Total energy | 17,328 foot tons |
| | Energy per kilogramme of gun | 0·559 foot ton |

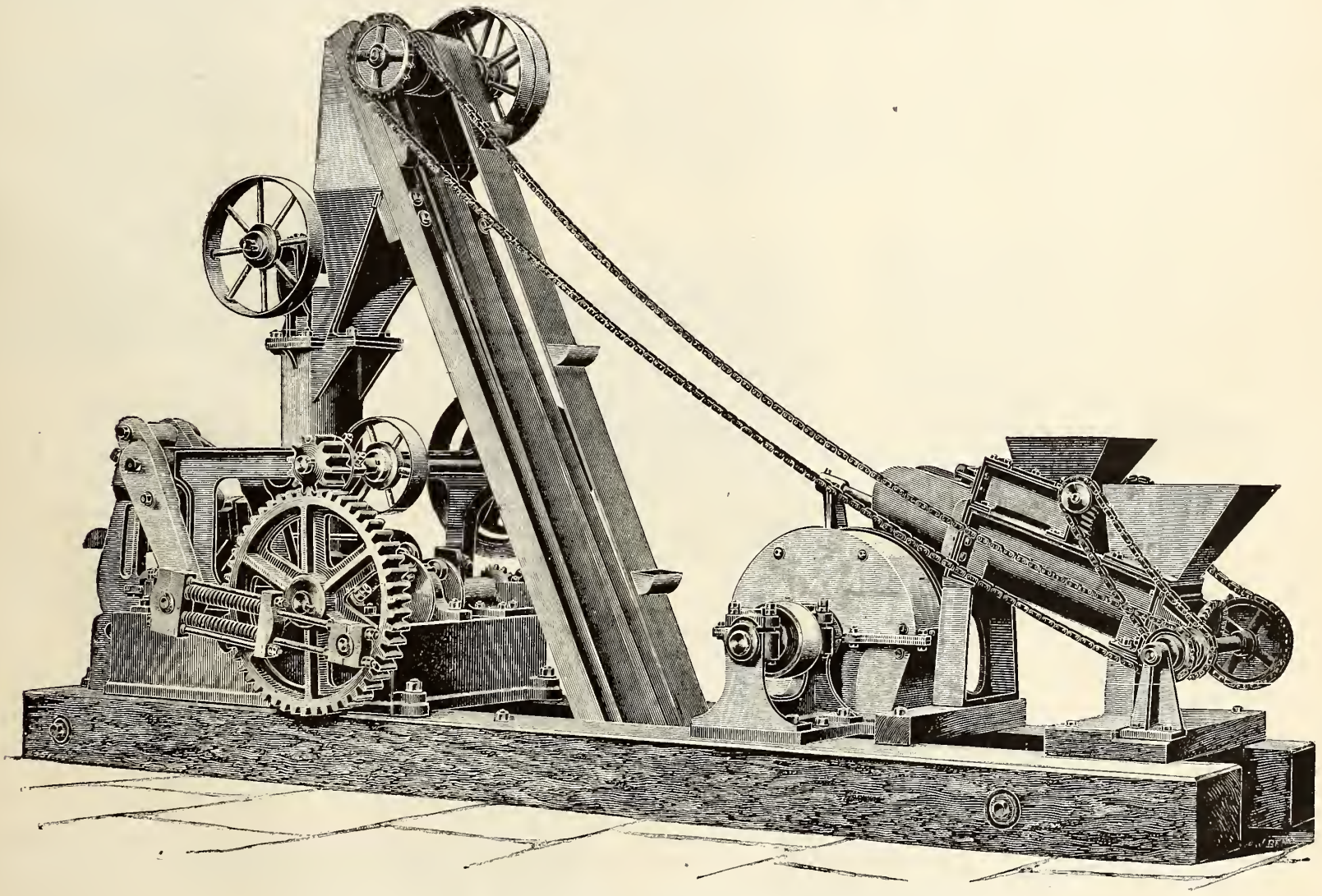
### THE 21 CENTIMETER (8·26 IN.) GUN.

The 21 centimeter (8·26 in.) gun was exhibited mounted on a center-pivoting naval carriage. The length of the gun is 35 calibers, and it is specially intended for large gunboats or the smaller class of ironclads. The mounting possesses some features of special interest; it consists, as usual, of the upper carriage, the underframe, and the turntable. The gun is mounted by its trunnions in the upper carriage, in the sides of which the hydraulic brake cylinders are formed, the piston rods of these cylinders being attached to the forward end of the lower mounting. The turntable to which this latter is attached revolves on a central pivot, and is supported on a live ring of steel balls. The gun can be revolved horizontally with gearing worked by hand; the elevation of the gun is effected by means of a toothed arc attached to the gun, and suitable gearing. Connected with the hydraulic brake of the carriage is a running-out brake by which the gun is held at the end of the recoil, or it may be held in any desired position upon the slides. Besides the hand training gear the mounting is supplied with an electrical driving device for effecting all the necessary manipulations, including the projectile crane. An electric motor mounted on the left side of the frame operates the elevating gear, while the motors for the horizontal training, and for working the ammunition crane, are placed on the right hand side of the mounting. The electrical and hand gears can be thrown in or out of service at will. The gun and carriage are protected by a steel shield 0·98 in. thick attached to the turntable. The maximum elevation that can be given to this gun is 25°, and the maximum depression is 5°. The weight of the mounting is 14·90 tons, and that of the shield is 6·98 tons. The following data refer to the ammunition employed with this gun:

| | |
|---|---|
| Weight of projectiles | 308·6 lb. and 238·1 lb. |
| Cast iron shells, bursting charge | 11·02 lb. and 8·82 lb. |
| Steel shells, bursting charge | 18·74 lb. and 14·33 lb. |
| Armor-piercing shells, bursting charge | 3·09 lb. and 3·09 lb. |
| Steel shrapnel, bursting charge | 3·09 lb. and 2·43 lb. |
| Number of balls in shrapnel | 975 |
| Weight of each ball | 0·11 lb. |

Both brown prismatic and smokeless powders are used with this gun, the charges being 51·8 lb. of the former with a 238 lb. projectile, and 50·7 lb. of the latter with a 308·6 lb.; the maximum ranges, with an elevation of 25 degrees, are respectively 14,436 and 15,037 yards; the total striking energies are 9,012 and 9,616 foot tons.

Up to the date of the exhibition the 21 centimeter gun shown had fired 74 rounds with full charges at the practice grounds at Meppen; of these, 40 rounds were fired with brown prismatic, and 34 with smokeless powder.



## IMPROVED MACHINERY FOR MAKING BRIQUETTES.

### BRIQUETTE MACHINE.

THE illustration shows one of the latest designs in briquette machines made by Mr. Robert Middleton, Leeds, and given in a recent number of *Engineering*, with the following particulars. Hitherto Mr. Middleton has made these machines of large size only, turning out 5 tons per hour, but a demand for smaller ones having arisen, they are now made in four sizes, from half a ton per hour upward, specially adapted for coal merchants, who, with small manufacturers, will, it is anticipated, find them very useful and convenient. The briquette made is of a small handy size, and adapted for household purposes, weighing, as desired, from ¾ lb. to 3 lb. each, and the whole plant is placed upon a strong wooden frame which requires no foundations and makes the whole installation self-contained.

The plant shown consists of a mixing and measuring machine, a disintegrator, a set of chain elevators, and the briquette machine itself.

The coal and pitch, or other binding material, are first fed into the mixing and measuring machine, in which the required percentages of both coal and agglomerant are measured and mixed together. The percentages can be varied by means of change wheels on the machines, so as to suit different classes of coal or agglomerant, or deal with more agglomerants than one at the same time. From this the materials fall through a hopper into the disintegrator, inside the cover of which are steel cages fitted with steel bars. These cages are driven in opposite directions at a high speed, grinding and mixing the materials together thoroughly. The bars in the cages are made replaceable, so that when worn they can be easily taken out and replaced with new ones, which is a great improvement over machines with fixed bars, saving a large expense in repairs.

After being thoroughly ground and mixed together in the disintegrator, the materials fall into the elevator box, and are lifted by the elevator into the vertical heater of the briquette machine. Here they are again mixed together, and heated by steam which is injected either into the materials or into a steam jacket, as desired. This heater is fitted with adjustable knives working on a vertical shaft, which pass the materials into the pugmill of the machine. From this they are fed into the mould plate in measured quantities, they are pressed in moulds, and are turned out in the shape of finished briquettes ready for using. The ability of the machine to turn out consecutively briquettes of the same size and weight is an important factor where they are disposed of retail by number and not by weight. The machine is designed on the same principle as the large ones. In it the briquettes are subjected to two different pressures, are pressed on both sides simultaneously, the pressure applied equaling about two tons per square inch. This insures the briquettes being solid and firm, and enables a saving to be made in the amount of pitch or other agglomerant used, as it has been found, after extensive experiments, that this pressure, applied to both sides simultaneously, is the best that can be used for this purpose. The pressing itself is done by leverage only, no steam being used excepting for heating the materials to a plastic state. The corners and edges of the briquette are all rounded off on both sides, thus giving it a better appearance and saving the loss in weight in transit which is occasioned by the crumbling away of square edges. It will be seen that the process is entirely automatic after the materials are first fed into the measuring machine. Very little power is required for driving the whole plant. These machines are not designed simply for using pitch as the agglomerant, but various other binding mixtures can be utilized equally as well.

## TRANSPARENT CONDUCTING SCREENS FOR ELECTRIC AND OTHER APPARATUS.*

IT is well known that electrostatic instruments require to be screened from outside electric disturbance, in order that their indications may be correct; but it is not so generally recognized that instruments intended to measure small forces, such as certain types of electro-magnetic voltmeters, delicate vacuum gauges, etc., are liable to give wrong readings from an electric attraction being exerted on the pointer, such as is produced by the glass cover when it is touched or cleaned.

There is on the table here a well known type of gravity electro-magnetic voltmeter, which may be found on the switchboards of many English and Continental electric light stations. At the present moment its terminals are not connected with the electric

* A paper by W. E. Ayrton, F.R.S., and T. Mather, read at the Institution of Electrical Engineers on April 12.—*Nature.*

light mains of the building, so that it should indicate zero pressure. Let me, however, but stroke the right hand side of the glass cover with my finger, and the pointer, as you see, at once turns to eighty volts or more. Conversely, let the terminals of the voltmeter be connected with the electric light mains; the pointer should point to about 100 volts, for that, as you know, is the pressure supplied by the Westminster Company. The voltmeter appears to be indicating correctly, but, on stroking the left hand side of the glass cover, the pressure, as read by the instrument, appears to suddenly fall to some forty volts. And a similar effect is produced if a piece of wash leather or dry waste be used in place of the finger.

If, then, it is possible to cause this instrument to indicate at will sixty or eighty volts too high or too low, how impossible must it be to feel sure that the glass cover—which is, of course, maintained in a dry condition in a hot engine room—has not been electrified by some accidental touch of the coat sleeve sufficiently to cause an error of three or four per cent. in the reading of this voltmeter!

We find that it is not merely with this particular type of voltmeter that an error can be produced by stroking or rubbing the glass cover, for other electromagnetic instruments that we have tried can also have their pointers deflected in the same way, but not to the same extent.

Nor, of course, is this source of error in any way connected with a voltmeter being an instrument constructed to measure an electrical magnitude, for it would equally exist if the glass were clean and dry and the controlling force remained of the same magnitude, no matter what was the quantity the instrument was constructed to measure. For example, on the table there is a vacuum gauge the wheel sector pinion of which has been replaced with an Ayrton-Perry magnifying spring. This gauge is, no doubt, very sensitive, for you observe that the pointer moves even when I produce an extremely slight diminution of pressure by rotating the short length of India rubber tube as slowly as I can; the change of pressure on pinching the tube, or even on dropping it, is indicated by the pointer. On the other hand, the pointer is of glass, and, therefore, is not suitable for being acted on by an electrostatic force; still, a stroke on the glass cover, as you see, causes the pointer to deflect through several degrees.

It has been known for a long time that it is possible to screen an instrument from such outside electrostatic disturbances by surrounding it with a metallic cage composed of wire or of strips of tinfoil. Such a method of screening, however, has the great disadvantage that it renders it difficult to observe the exact position of the pointer from a distance, for the wires or strips of tinfoil cover up the pointer more or less. We, therefore, thought of placing the pointer underneath the metallic dial of our electrostatic voltmeters, and of only allowing the tip to project through a slot in the dial plate. But this method we abandoned on trying it eighteen months ago, for to make the screening good the visible part of the pointer must be reduced to a spot, and the exact position of this spot we found less easy to read at a distance of several feet than that of a long black line, which is the appearance of a pointer when it is visible along its whole length. This method of screening has, however, we understand, been recently adopted by a firm of instrument makers.

We next considered whether it was not possible to make a perfectly transparent conducting screen, so that, while the electrostatic screening of the pointer should be practically perfect, the pointer and dial should be as easily seen as if the screen were not present. Our first idea was to make the glass cover double, and to insert between the two sheets of glass a layer of clear conducting liquid. Fearing, however, trouble from leakage of the liquid, or from the liquid becoming gradually turbid and giving the dial a dirty appearance, we turned our attention to depositing films of solid matter on the inside of the glass cover or shade, of sufficient thinness to be practically transparent, but with the solid particles near enough together to be conducting. We tried smoke, silver deposited in layers of various thicknesses, mercury vaporized and deposited, sal-ammoniac vaporized and deposited, etc., but we were quite unable to obtain in this way both transparency and electric conduction.

After a conversation with Prof. Boys, when discussing the problem that we were then engaged in solving, we commenced experimenting on varnishes, with the view of arriving at a varnish which should be as hard and as transparent as clear shellac, but which, instead of being an insulator like shellac, should be a sufficiently good conductor to allow of the instantaneous production of an induced electric charge to balance the electrostatic action of any outside body. Glass plates were coated with gum, with coaguline, with the gelatinous electrolyte used in accumulators (composed of sodium silicate and dilute sulphuric acid), with isinglass dissolved in acetic acid, with gelatine dissolved in acetic acid, with isinglass dissolved in a mixture of acetic and sulphuric acids, and with gelatine dissolved in the same mixture. After much experimenting, we arrived at the following two methods of coating a glass cover, or shade, which gives perfectly satisfactory results:

No. 1.—Dissolve ¼ ounce of transparent gelatine in 1 ounce of glacial acetic acid by heating them together in a water bath at 100° C. To this solution add half the volume of dilute sulphuric acid which has been prepared by mixing 1 part of strong acid with 8 of distilled water by volume, and apply the mixture while still warm to the glass shade, which should be previously polished and be warm. When this film has become very nearly hard, apply over it a coating of Griffith's anti-sulphuric enamel.

Method No. 2.—Thin the gelatine solution, prepared in the manner previously described, by the addition of acetic acid (say 2 volumes of acid to 1 of the solution), and, after polishing the glass, float this thinned solution over the glass cold. Drive off the excess of acetic acid by warming, allow the glass to cool, and repeat the floating process, say, twice. Thin the anti-sulphuric enamel by the addition of ether, and float it over the gelatine layer applied as just described. Expel the ether by heating, and apply a second layer of this thinned anti-sulphuric enamel.

With experience, such as Messrs. Elliott and Messrs. Paul have at length acquired after much practice, a layer can be applied, either according to method No. 1 or No. 2, so that, when finished, it is quite hard to the touch, and so transparent that it is only by looking at the glass plate obliquely that the presence of the varnish can be detected.

It is also so conducting that when a P. D. of several thousand volts, alternating with a frequency of 200, is set up between the needle and inductors of one of our electrostatic voltmeters, the pointer, which is metallically part of the needle, is not visibly attracted by a metallic rod held just outside the glass close to the pointer, this metallic rod being electrically connected with the stationary inductors.

Without experience, however, it is somewhat difficult to apply the coating so that it is not either cloudy or a comparatively poor electrostatic screen or both.

This second electro-magnetic voltmeter—which, like the former, has been kindly lent us by Mr. Barley, of the Knightsbridge electric light central station—looks exactly like the other one, and, indeed, behaved exactly like the other one when we received it. It has, however, had a layer of our transparent varnish applied on the inner side of the glass subsequently, and you will find that you may rub the glass as much as you like, or even hold a rubbed stick of ebonite near it, without producing any effect on the pointer.

Again, these two clear glass shades, belonging to gold leaf electroscopes, are one of them coated with our varnish, and the other not. Which is the uncoated one is at once apparent from the alteration produced in the deflection of the gold leaves when I approach a stick of rubbed ebonite near the lower part of the glass shade of the uncoated one, for no such change in the deflection is produced, as you see, when the ebonite rod is brought near the glass shade, which is protected by a layer of this varnish applied on the inside.

## IMPROVED STEREO-MATRIX PROCESS.

A DEPARTURE from the present method of forming stereotype moulds for newspaper and other classes of printing work has, according to *Engineering*, recently been devised and patented by Mr. G. Eastwood, of Norwich, Eng., and has, we are informed, been already applied practically at several important offices. The principal objects which the patentee had in view in working out this process were to dispense with the present methods of "beating" and "mangling" the matrix, and to expedite the drying of this matrix, in order to promptly release the form and to get the mould quickly into the casting box. The benefit to be secured by such ends may be gathered from the fact that, according to the present, or "beating," etc., process, some seven to twelve minutes are occupied in the moulding and drying of a matrix, while it is claimed that by Mr. Eastwood's invention the moulds can be made ready to be cast from in less than half a minute. If really satisfactory moulds can be produced in anything like this time, the matter is, of course, one of great importance.

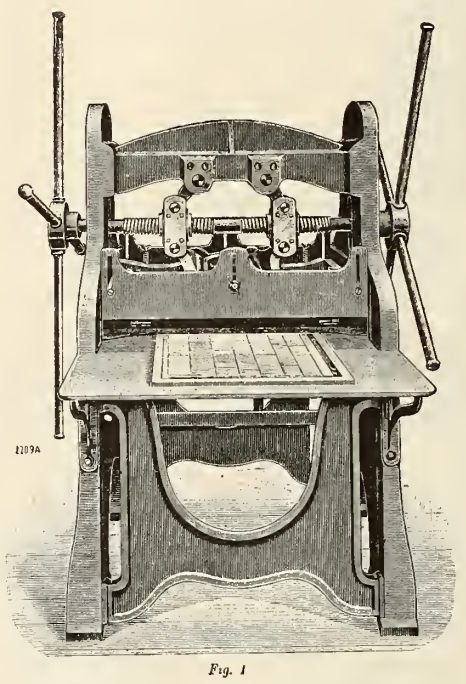
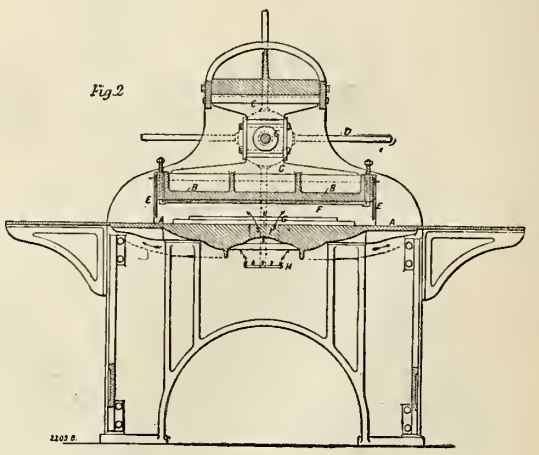


Fig. 1



IMPROVED STEREO PRESS.

The majority of daily newspaper readers may scarcely realize the fact that the type as "set up" in the composing room of most offices never touches the ink or the paper which is used to form the news sheets; that which produces the reading matter is simply an exact impression or mould of the type page in solid metal, called the "stereotype," cast in such a way as to be suitable for attachment to the cylinders of the rotary machine. No matter to what perfection the printing machine or composing contrivances may be brought, in order to meet the requirements of the times, stereotyping is and will be necessary to complete the "connection," and the more perfect it is in saving time and performing the work in a satisfactory manner, the more valuable will the rotary machine become as a rapid printing appliance.

According to the ordinary methods of obtaining moulds from type, etc., from which in turn the "stereo metal" castings are taken, the hot or cold wet or moistened "flong" is, after being laid upon the type, beaten with hand brushes and then rolled, after which it is, with the form," placed under a press mounted on a steam heated slab. The form with the mould on it remains on this slab until the mould is dry or nearly so. These operations, as before mentioned, necessarily occupy several minutes to carry out.

The essence of Mr. Eastwood's method consists in the substitution of a single press, with platen action, for the above mentioned appliances for beating, mangling, and drying. The type bed of his new press forms also the base of the heating chamber, while the platen adjusts the flong and removes it after pressure has been applied, suspending it in the drying chamber between heated currents of air. At the moment of contact with the type the flong is moist and plastic, and in the act of consolidating is heated so that the least possible time is taken in completing the drying. When the pressure is removed, the form is immediately released, either for duplicating the matrix or for removal to the composing room. "Packing" the mould to fix the "blanks" is said to be generally unnecessary, owing to the rapidity with which the composition of the flong is fixed; but this is a point on which we should be glad to learn the results of further experience.

The "flong," or materials in which the impressions of the type are taken, may roughly be said to consist of a layer or number of sheets of blotting or other paper pasted together, which in turn may, if desired, be covered by one or more sheets of tissue paper or muslin. According to the present existing practice the flong is often composed of some five or six separate layers of paper, whereas Eastwood's flong is formed of only two or three sheets. The compositions or agglutinating materials used in these productions are, more or less, the occult property and art of the stereotyper. Mr. Eastwood, however, says that the composition he employs is essentially one of an ordinary known character, although we are inclined to believe that there is more mystery in the flong itself than the patentee wishes at the moment to disclose, although it is protected.

Referring to the illustrations given herewith, Fig. 1 represents an end elevation of, and Fig. 2 a vertical section taken through, Mr. Eastwood's moulding press. A (Fig. 2) represents the metal type bed or table, which is heated by suitable means, and is supported upon a cast framing. B is the "platen" or top plate of the press, which works freely in vertical guides by means of the toggle lever movement, C, actuated by the right and left handed screw spindle, upon the extremities of which the starwheel, D, is keyed, so that hand power may be conveniently applied to the apparatus. To the platen are attached the end covers or inclosing plates, E, arranged so as to confine the heat as far as possible within the area of the former, when it is raised in order to allow the press to be opened; these plates are secured by bolts working in slots, as shown, in order to accommodate the vertical movement of the platen. The latter is connected with the toggle action by a free pin or knuckle joint to allow it to accurately adjust itself to the surface of the type. F represents a frame or "frisket" suspended by a spring-holding device immediately below the platen for carrying a "blanket" or cloth, while G indicates a "form" (*i. e.*, keyed up columns of type) in position for taking a mould.

The type bed, A, for receiving the "form" below the "platen," B, is heated from beneath by means of gas jets, H, the products of combustion being allowed to pass into the area confined within the bed, pressing plate, and covers, E, by suitably located slots or apertures, I, shown by dotted lines in Fig. 2, the arrows indicating the manner in which the heated air is caused to circulate. Obviously by raising or lowering the gas flames the temperature can be regulated to a nicety; it is stated that in practice the temperature need not exceed 200° F. It will, of course, be readily understood that, if desired, or more convenient, the press can be satisfactorily heated by means of steam.

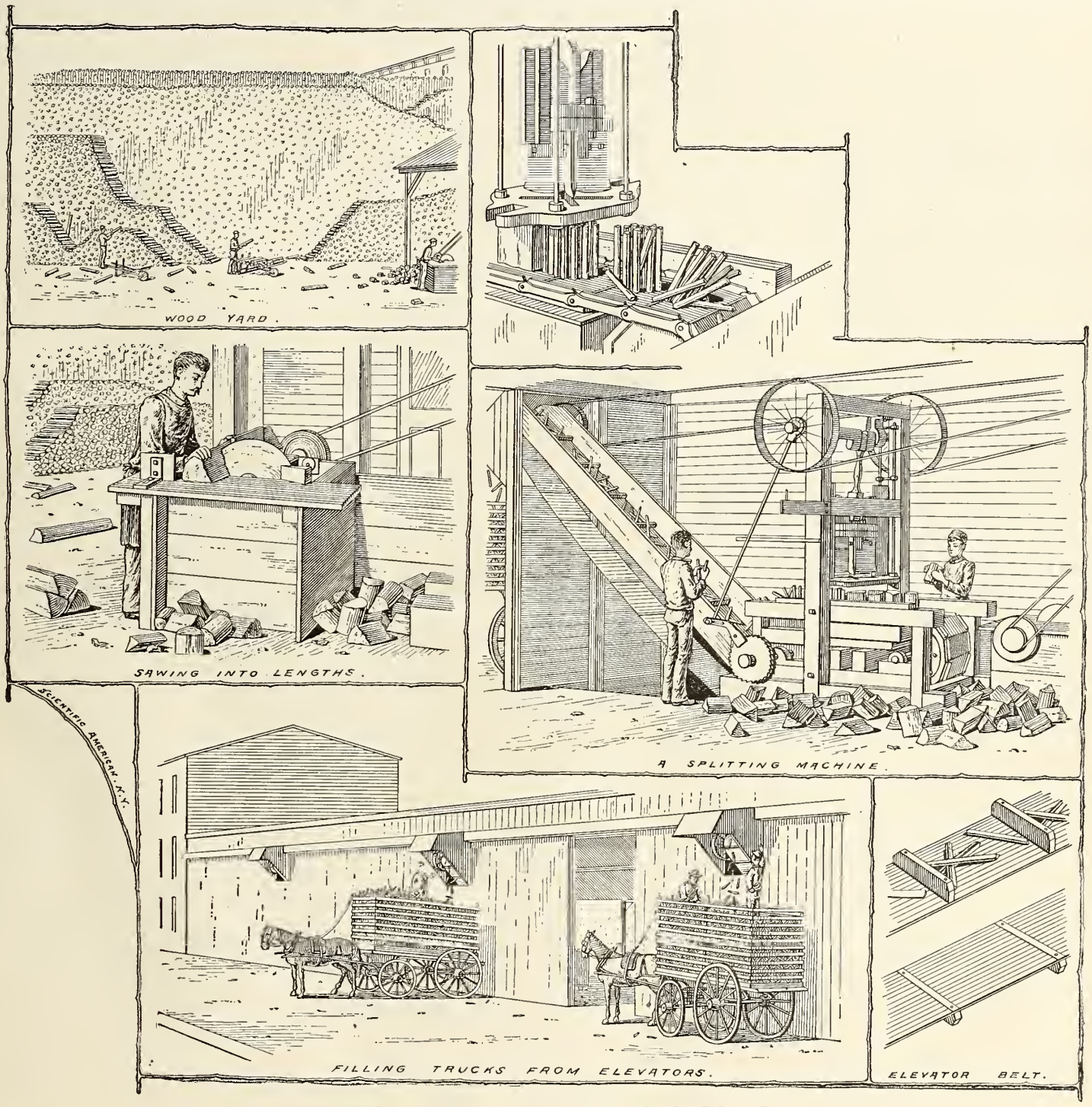
The form having been handed to the stereotyper, he places the moist flong upon the face of the type, and then inserts the latter into the machine, gradual pressure being applied by turning the handwheel, D. Immediately sufficient force has been exerted, he releases the platen and withdraws the form, and the process is complete, the time occupied being, as before stated, about twenty to thirty seconds. The mould is now ready for the stereo casting box in which the curved or flat metallic reliefs are obtained. The process being conducted between the hot bedplate, blanket, and platen, immediately the pressure is released the mould is finished ready for being cast from, although the temperature used seldom exceeds 175° F. This comparatively low temperature readily permits of impressions being taken from woodcuts or illustrations in an efficient manner without risk of cracking or breaking the blocks. The patentee attaches much importance to the freely mounted platen, which adjusts itself to the face of the type or block from which a mould is to be taken.

ONE of the chief men in a Mohammedan caravan is the cat sheik, or "Father of Cats," who rides a camel carrying dozens of baskets filled with cats.

## STEAM KINDLING WOOD MANUFACTORY.

The pine kindling wood that is used in this section of the country comes principally from the forests of Virginia. The trees are first cut down and the trunks quartered and sawed into proper lengths. The wood is then carted to the coast, packed into sailing vessels and brought to this section, where it is bought up at the docks by the dealers and manufactured into kindling wood, being first sawed into short lengths, then passed through a steam splitter which carries the pieces to an elevator which in turn passes them along and drops them down into the delivery wagons. The pieces of timber, which are four feet six inches in length, are first sawed into eight and one-half inch lengths, the saws used for this purpose being thirty inches in diameter, one-eighth of an inch thickness, having fifty inch and a quarter teeth. These saws make about two thousand revolutions per minute, the attendant being able to saw up about from twelve to fifteen cords per day. The pieces as fast as they are sawed are passed to the steam splitter. They are first placed end up on to a movable endless chain, which, by the aid of two hexagon wheels and a ratchet wheel which is worked by an eccentric, causes the chain with the wood to move along under the knives, which pass down through the pieces of wood, splitting each of them into a dozen or more pieces. The knives are four in number and bolted into a cross head. They are twelve inches in length, six inches in width and three-quarters of an inch in thickness. The knives pass up and down a perpendicular slide with a twelve inch stroke, making about eighty cuts per minute. The endless chain is twelve inches in width and passes over a wooden bed, the top of which is covered with an iron plate which protects the chain from the blows of the knives when striking the wood. At every downward stroke of the knives a movable bearing which the knives pass through holds the pieces of wood down firmly against the chain. With the upward stroke it releases the split wood, which is moved forward about two inches at a stroke by the chain, which is worked by the ratchet wheel and eccentric. The pieces of wood then drop down into an elevator at the end of machine and are carried off to the delivery wagons by a number of buckets belted to a twelve inch cotton belt. These buckets are eighteen inches apart and made of wooden strips three inches in height, and about one and one-half inches in thickness. They are held in place by being bolted to narrow iron strip on the underside of belt. The belt is about thirty-five feet in length and travels about one thousand feet per minute. The splitting machine can cut about twenty cords per day. A delivery wagon holding about one cord can be filled in about fifteen minutes. The wholesale of Virginia pine at the dock is from $7 to $8 per cord, the manufactured kindling wood bringing from $11 to $13 per cord.

The sketches were taken from the plant of Clark & Wilkins, New York City.




MANUFACTURE OF KINDLING WOOD.

## GASEOUS FLUORIDES.

A RECENT number of *Nature* states that a detailed account of his investigations concerning the gaseous fluorides of the simpler organic radicals is contributed by M. Meslans to the March number of the *Annales de Chimie et de Physique*. The fluorides of methyl and ethyl have already been fully described by M. Moissan and other workers, and the fluorides now described are those of the radicals propyl, isopropyl, allyl and acetyl, together with the interesting analogue of chloroform, fluoroform. Propyl fluoride may be obtained by reacting with the corresponding chloride, bromide or iodide upon anhydrous fluoride of silver. The iodide is most convenient, as it reacts at the ordinary temperature, while propyl bromide requires heating to the neighborhood of 100°, and the chloride to a still higher temperature. The reaction between propyl iodide and silver fluoride may be best carried out in a copper tube immersed in tepid water. The propyl iodide is admitted to the tube already containing the silver fluoride from a dropping funnel, and the gaseous product of the reaction passes upward through a leaden condensing worm cooled by iced water and subsequently through three U-tubes containing fragments of silver fluoride, and finally through a delivery tube to the mercury trough over which the gas is to be collected. The reaction does not simply result in the formation of propyl fluoride and silver iodide. A third substance is produced, a red solid substance which is found to be an iodo-fluoride of silver of the composition $Ag_2FI$. The amounts of propyl fluoride and of the latter substance obtained correspond to the equation

$$C_3H_7I + 2AgF = C_3H_7F + Ag_2FI$$

Propyl fluoride is a colorless gas possessing an odor similar to that of the analogous chloride. It burns with a brilliantly luminous flame forming aqueous vapor, carbon dioxide and hydrofluoric acid. It liquefies at — 3° at the ordinary pressure to a colorless mobile liquid which is without action upon glass. The difference of boiling point between this liquid and propyl chloride ( + 45° ) is 48°, about the same as that between ethyl fluoride and chloride, and almost twice as great as that between the chlorides and bromides of the two radicals. The gas is decomposed by melted sodium, with sudden and brilliant incandescence, accompanied by deposition of carbon. It is soluble in water to the extent of one and a half times the volume of the latter. Isopropyl fluoride and allyl fluoride are prepared in a similar manner from the corresponding iodides. They are both gaseous substances capable of condensation to liquids by reduction of temperature or augmentation of pressure. A mixture of allyl-fluoride with four times its volume of oxygen explodes with great violence under the agency of an electric spark, or when brought in contact with a flame.

Fluoroform, $CHF_3$, has been prepared in the pure state by M. Meslans only after repeated unsuccessful attempts. When free fluorine from the platinum delivery tube of the electrolysis apparatus is allowed to escape into chloroform an energetic reaction occurs, chlorine is liberated, and in a few moments an explosion is produced, with copious formation of carbon tetra-fluoride and fluoroform. If the fluorine is caused to enter a vessel containing air charged with vapor of chloroform, an immediate explosion is produced. When finely powdered silver fluoride and iodoform are mixed a vigorous reaction also occurs, usually with incandescence, and the fluoroform produced is contaminated with other gaseous products. The reaction may be modified, however, by adding chloroform and cooling with ice, and the gas may be purified from chloroform by passing through alcoholic potash, which is without action upon fluoroform, from carbonic oxide, which is usually present in small quantity, by means of a solution of cuprous chloride in hydrochloric acid, followed by desiccation over fused potash, and finally from last traces of impurities by passage over silver fluoride heated to 150°. The gas thus treated is pure fluoroform, a gas which liquefies at 0° under a pressure of twenty atmospheres. It is incombustible, but imparts a bluish green color to a Bunsen flame when injected into it. It is insoluble in water and possesses an odor similar to, but feebler than, that of fluoroform. The action of free fluorine upon it is interesting. A flame is produced at the end of the platinum tube delivering fluorine, and the one atom of hydrogen contained in the fluoroform is extracted and converted into hydrofluoric acid without any deposition of carbon, the latter element being at the same time entirely converted to the gaseous tetra-fluoride.

# CHEMISTRY IN RELATION TO PHARMACO-THERAPEUTICS AND MATERIA MEDICA.*

By Prof. B. J. STOKVIS, of Amstersdam University.

## THE TERM AND SCOPE OF PHARMACO-THERAPEUTICS.

"THERAPY" or "therapeutics," by which terms we understand the art of serving the cause of humanity by assuaging human suffering and healing human ill, avails itself of every means in its power to arrive at these ends; *elle prend son bien ou elle le trouve.* And the art of therapeutics, like all of us here assembled at this Eleventh International Medical Congress, has discovered that all ways lead to Rome. To Rome therapeutics has come, now in the guise of electricity, now as a water cure, now as psychical influence, so that we here are able to review, as they defile like armies before us, electro-therapy, pneumo-therapy, hydro-therapy, hypnopsis, and psychic suggestion, and compare their merits as healing agents when placing themselves at our orders to combat disease and put death to flight. But most ancient of all the branches of medical art is that which makes use of drugs; and in the hands of the inexperienced drugs can cause death (*Φαρμακεια*—the use of medicines or poisons), so that the science and art of the introduction of medicaments into the human body with the view of healing it carry with due right the appropriate title of "Pharmaco-therapeutics." And at one time, pharmaco-therapeutics was the most important branch of the healing art, though in our days it has declined and occupies but a second, or perhaps, I should say, third place; operative surgery, proud of its victories, and as admired as admirable, full of vigor and sap, has distanced the ancient branch. And again, we see hygiene, young, fresh, lovely, and assured beforehand of all suffrages, taking its place in the front of all medical science, confident in the future success of its attempts to render the arts of healing superfluous by preventing the malady. Why, then, it may be asked, do I essay to interest you in an art which seems to be growing old under our eyes; whose past, it is true, is very honorable, but whose future hardly seems to promise the triumphs that have fallen to the lot of surgery and of hygiene. My reply is simple—because we shall not be able to dispense with this essential branch of our art; because, as much in external as internal medicamentation, we must for the present make use of pharmaco-therapeutics.

## THE PRIME IMPORTANCE OF CHEMISTRY.

The substances that we employ in medicine are composed of chemical bodies, or are, perchance, pure chemical bodies; and to understand their physiological action we must have recourse to biology and chemistry; while to appreciate their application in disease it is necessary to study pathology and therapeutics. Chemistry, in its wide sense, enables us to understand the composition, the structure, and what I would term the affinities of a substance, as it is chemistry that enables us to analyze by tests, and to construct and reconstruct by synthesis. The relations between chemistry on the one hand and pharmaco-therapeutics and materia medica on the other are so intimate, so indissoluble, and so obvious that it almost seems to me superfluous to trouble you with their consideration. However, you will not mind, I hope, if I take the liberty of submitting to you a few points which may not be new, but which at any rate have the merit of being *apropos*, and may by thought upon them make us better appreciate chemistry. To pile stones on the top of each other is not to construct an edifice. Without a definite plan, without a general view—that is, a comprehensive conception of the whole constructive scheme—there can be no scientific edifice durably reared. Therefore, it would not be sufficient to constitute pharmaco-therapeutics a science to say that if it has arisen without preconceived ideas, it is founded upon observations extending from the most ancient date with regard to the effects produced by the administration of certain substances to the sick; nor is it sufficient to claim that pharmaco-therapeutics has availed itself of experiments on healthy man and on animals, and has taken into consideration physiological results and the fruits of clinical study. A sound basis of operation from which to inquire into the use of medical substances is required. We must know, if we would satisfy the claims of science, the mode of action of these substances, and understand how it comes about that they possess the power to produce or remove functional troubles. And it is here that chemistry comes to our aid—chemistry in general, chemistry in its largest sense. I in no way lose sight of the incomparable services of biological chemistry and physiological experiment. Who of us would overlook the assiduous and successful work of Coppola, Gracosa, Pellacano, Albertoni, and of all that young Italian school that is now marching victoriously along the route traced out for them by Fraser and Brown? The method of action of medical substances has been and will be rendered more clear and comprehensible by their researches; but this is not enough. The conscientious striver after truth will always find himself face to face with one problem, a problem in the solution of which lie concealed—an inextricable secret so far—the true phenomena of life. We recognize this; for everywhere, where we are powerless to comprehend the action of medical substances upon the living organism as being due to their own inherent properties, we do not hesitate to call to our assistance the unknown properties of living protoplasm, and attribute the phenomena to them; but it is chemistry that should tell us that we must not be discouraged by the enigma of life. Enigma there is doubtless, but let us recall that Lavoisier first named life "a chemical function," and that—once given that the creature lives—from that it obeys neither more nor less than dead or material nature the general laws of chemistry.

## VITAL PHENOMENA AND THEIR MEANING.

The familiar phrases "living force" or "vital phenomena" serve us to designate the outward expressions of condensed energy in dead material, being borrowed from the manifestations of life. In dead material, we are all aware, force can appear as thermal energy, as electricity, as light, or as mechanical expression, and we can go back along this line of transformations and see all the changes unmake themselves. In living protoplasm—considered as the unit of the psychic and reproductive functions—the essential phenomena are the same. There is the same change of *roles*, the same production of warmth, electricity, mechanical energy, and chemical energy. We know that the living cell "reacts," as we please to term it, to variations of temperature, electricity, light, and energy, chemical and mechanical; but this irritability in the cell, this aptitude of the cell to change one form of energy for another, resembles the transformations that take place in dead material, as the stimulants of the living cell, without which the vital phenomena do not appear, are just the different forms of energy which arrive to it from its environment, and which it changes into chemical energy.* For life the cell must have warmth and moisture. Take away the moisture or lower the temperature to the necessary point, and life becomes latent or disappears. In dead nature the same takes place. We are all familiar with the admirable experiments of Professor Pictet, bearing upon this point. He proved by them beyond dispute that chemical energy disappeared and reappeared in accordance with the temperature to which certain substances were submitted, and that water is every whit as indispensable as a proper temperature for the maintenance of the phenomena of life. Certain it is that life is a chemical function, but the point is, Is not the chemical function a sort of life? Did not the father of medicine show a wonderful insight in counting water and fire among the four elements of which the universe is composed?

Now if we examine closer the special problems which fall within the scope of pharmaco-therapeutics, if we examine the results which follow the introduction of drugs—healing or poisonous—into the organism of man and animals, it must appear that we can never learn how to solve the problems without looking for their explanation in these "vital elements," as I may term them. The manifestations of their agency in the behavior of living organism have so characteristic an imprint that even Claude Bernard himself did not hesitate to place chemical and purely physical action in the comparative background. I will give examples of my meaning. How are we to understand the fact that the ingestion of infinitesimal quantities of certain substances which pass through the organism without causing in it the least change can provoke such disordered chemical actions as to occasion death? How are we to understand the fact that different parts of the organism seem to be able to distinguish these substances, the one from the other? We must admit special elective functions proper to the life of the cells. How are we to understand the facts that nothing but a change in the quantity of their dosage, the duration of their administration, and the method of their application suffices to make of certain toxic substances stimulants or paralysants? How are we to understand the fact that insoluble substances like arsenic, cannabis indica, and lead can defy that well known axiom, *Corpora non agunt nisi soluta*, and manifest therapeutic and toxic action? We must admit the presence and agency of some unknown power within the living cell. How, again, are we to understand the therapeutic power exhibited by solutions of iodine and bromine which have apparently been diluted to the deprivation of all chemical action, unless we attribute to the living cell the power of liberating the iodine and the bromine from such dilute solutions? Thanks to my compatriot and dear colleague at the University of Amsterdam, Professor Van t'Hoff, thanks to the admirable work of Arrhenius and of Ostwald, thanks to congresses of physicians and chemists, light seems to me to be about to be shed upon all these dark places in pharmaco-therapeutics. And it has not been Mahomet who has gone to the mountain, but the mountains which have come to him. In other words, the study of the chemical affinities of dead matter has revealed to us the secrets of the living cell.

## THE APPEARANCE OF "VITAL PHENOMENA" IN CERTAIN CHEMICAL SOLUTIONS.

We have been accustomed to regard the neutral solution of sugar or of some neutral alkaline salt in water as an inert liquid deprived of all molecular power. We know to-day that such a solution must be held to possess the same kinetic power as if the substance dissolved were present in the gaseous state. Placed in contact with other solutions it will exercise pressure according to the laws that Avagrado and Dalton have discovered for gas. It will exercise an osmotic pressure in direct proportion to its molecular weights. But this is not all. We have to remember the electrolytic phenomena of such solutions by which their kinetic power may be rendered enormous. This conception of the molecular properties of solutions is of the highest importance both in biology and pharmaco-therapeutics. It is not by accident that life is so closely leagued, as it were, to water. It is not by accident that living organisms contain without exception more water than solid properties, that they contain much more of it in proportion than any other terrestrial object of palpable and visible formation. It is not by accident that the youngest and most energetic organisms, those in which life is the most intense, are distinguished by containing the most water, while the tissues in which life is ready to expire have the least. Life has been compared to a torch. From a chemical point of view life is not only a torch—it may also be compared to a river. It is an ocean in which the molecules of the chemical substances there constantly dissolve, constantly develop chemical, electrical, thermal and mechanical energy, an energy whose seat is the living cell.

From all of this it follows as an absolute necessity that the chemical actions which constitute vital phenomena become stimulated, troubled, or altogether upset from the moment that we introduce into the system some new complicated substances in solution, whose molecular forces are now added to those of the cellular system. We are only embarrassed what example to choose when we seek in organic and inorganic chemistries proof of this point. I only wish to name one to you which seems to me conclusive. By warming pure chlorate of potassium we obtain pure oxygen, but the presence of the smallest quantity of chloride of potassium is sufficient to change part of oxygen into ozone. In giving rise to this development of ozone the chloride of potassium remains itself completely unaltered; but, what is more remarkable yet, this chloride of potassium itself has, like peroxide of manganese—which acts in an identical manner—the property of destroying ozone.

We find, then, here, as M. Brunck, to whom belongs the honor of having discovered the reactions, has said, a most remarkable phenomenon. We see a chemical substance, without itself appearing to undergo the least appreciable molecular change, favors the formation of a new chemical body, which, on the other hand, it has the power to destroy the moment that it is formed. There is, in fact, in the domain of organic chemistry, with no question of fermentation, a catalytic force, in considering which we have to make for dead nature a complete pendant of that which we should scarcely consider characteristic for therapeutic actions—the phenomena of excitement and paralysis, manifested by the slightest possible quantities of one and the same substance which itself remains unaltered! And speaking always with these phenomena before our eyes, and looking on the cell as a colloid or membraneous mass containing several substances, organic and inorganic, at the same time dissolved in water, there is no longer any reason to be astonished that slight changes in the quantity of one substance or the other, or that the presence in one of a body that is absent in the other, suffice perfectly to change the chemical affinity of the cells, as well as to differentiate them in such a manner that each of them seems to be endowed with an elective affinity peculiar to itself. As for the manifestation of therapeutic and toxic action by bodies considered to be insoluble, of which Nageli in a posthumous work has made so profound a study, they are also capable of the simplest interpretation. The insolubility of these bodies is not absolute, but only relative. If we throw, for example, metallic copper into water, and wait for some days, we shall find that a certain proportion of the copper has dissolved, *i. e.*, one part to seventy-seven million parts of water. The copper dissolves in this manner without the least intervention of any living organism. In the same way it is not the vital function of the human organism which makes arsenic, cannabis indica, and lead display active properties when introduced in a metallic state under the skin. It is the mass of water which is the agent (for the human body may be regarded as a jug of water containing forty-five liters) and the temperature.

The view that regards the solutions of salts as mediums in which the chemical molecules are perpetually striving to assert their individuality has contributed, on the other hand, in the most efficacious manner to elucidate the action of some of the drugs that are most in use. I have particularly in my eye now the purgative and diuretic salts, the chlorates, iodides and bromides, whose therapeutic effects are obtained upon doses that may be called massive when comparing them with the infinitesimal doses of which we have just spoken. Since my dear and honored colleague of the University of Amsterdam, Prof. Hugo de Vries, discovered the law of iso-tonic solutions, and since the admirable work of Prof. Hofmeister, of Prague, and his pupils, the effects of purgative and diuretic salts have been recognized to depend uniquely upon their pure chemico-physical properties. On the other hand, we owe to the zeal and perseverance of Prof. Hofmeister, of Prague, again a series of very beautiful researches on the imbibition of salt solutions by tablets of pure agar-agar gelatine, which demonstrate to proof that all that we have hitherto considered the elective affinity of the living cell can be explained in the most natural manner in the world by its colloid condition and chemical constitution. Add to this that the quickness of chemical action, according to the interesting chemical researches of Vladinarsky, is in no way impaired by the colloid state of the medium in which the substances are placed, and you will easily arrive at a conception of the immense progress that pharmaco-therapeutics has made by the agency of physical chemistry. Among the salts that I have named, the iodides and bromides are also to be found. Their therapeutic effects are, I need not say, altogether specific. What is more natural than the belief that we ought to attribute the results to the iodine and bromine themselves; and we all know that some long time ago, my colleague at the University of Bonn, Prof. Binz, has been able to demonstrate that it is the living cell which frees the iodine and bromide from solution. The fact is not, however, proved to universal satisfaction.

I should never finish my task if I tried to place before you all the points of the new view on the action of drugs, poisonous and otherwise, whose pharmaco-therapeutics are traceable to the theories of modern chemistry. Let us glance only at the catalytic fermentative actions which take place everywhere in live protoplasm, and which without doubt play a preponderating role in the therapeutic effects of drugs. These can no longer be considered the appanage of the living cell. They also take place in dead matter.

## CHEMISTRY IN RELATION TO MATERIA MEDICA.

If I now stop theorizing, it is not from fear lest any one in this Areopagus of science should say: To what practical good does all this tend? Evidently it is not to-day or to-morrow that the art of medicine will profit by chemistry. But all these new ideas have rendered necessary new methods of experimentation and new methods of investigation; and a new track is now being traced by human genius, along which there is much to discover; and from the moment that the new physical methods shall have been applied to the study of drugs (all honor to M. Dreser, who has here taken the initiative in his investigation into diuresis) medical art will profit and will find in chemistry a sure and trusty guide in its efforts to serve humanity.

In speaking of chemistry in its relation to materia medica I do not employ the words materia medica in the sense in which Discorides used them. I employ them in their strictest and primitive sense to mean the collection of drugs and medicaments in use in our days—our *thesaurus medicaminum.* Materia medica recruits from botany, zoology, and above all from chemistry; but its immense progress of late is due to chemistry. The active principles of almost all our drugs are now known to us. They have been isolated, prepared and elaborated; the chemical constitution of their active principles is no longer a secret.

* An address delivered at the Eleventh International Medical Congress, at Rome, 1894; from the *Lancet.*

* It must be remembered that all of this is qualified by Professor Stokvis' original reservation, "Once given that the creature lives."

We know that sugar and glucosides and aromatic oils belong to chemical groups, and are as well defined as the alkaloids derived from pyridine or chinoline. Every day the number of contumelious substances—substances which do not wish to reveal to us their secrets—grows less. Chemistry has revealed to us the presence of more than twenty alkaloids in opium, and of more than six in quinine; and it will soon be extremely difficult to name the drug, of animal or vegetable origin, in which there have not been found one or several active principles. And, going from victory to victory, chemistry has also succeeded in producing a great number of alkaloids by the synthetic manner. These have not been the exceptional lucky strokes (*coups de maitre exceptionels*). No constitution and composition of other bodies that chemistry has not yet reproduced for us is already familiar to the chemist who can transform morphia into codeia and *vice versa*, and worthless cupreine into effective quinine. We may predict with every confidence that the manufacture by synthesis of all the known alkaloids is only a question of time for chemistry. But the triumphal march of chemistry does not stop here; it has constructed for us new alkaloids endowed with therapeutic effects of great value. It has furnished us, *inter alia*, with apomorphine and apocolaine.

It would be unequaled ingratitude to fail to recognize the imperishable services that chemistry has rendered to materia medica in endowing it with the alkaloids and the pure active principles because there are a few black clouds on the horizon. That there are such I do not deny, but they are not wholly the fault of chemistry. Is the gunsmith responsible for the accidents that a new firearm may cause in the hands of a client who does not know how to use the weapon properly? Surely not. Why did not the purchaser take the trouble to understand the structure of the gun? Why was he not more careful? Why did he pay no attention to warnings? Why did he behave like a happy child, with nothing more important to do than to display his new acquisition to all the world and to put it to the test with the innocence of youth? On the other hand, should not the gunsmith help to avoid such disasters by explaining matters to the purchaser? And if he is not himself sufficiently informed and does not thoroughly understand the mechanism of the weapon, should he have offered it for sale? Either party may be to blame. What I want to convey by my parable is this: by a very pardonable illusion, to which the many physicians and some chemists have given way, it has become generally believed that the active principles of drugs, when chemistry can furnish them for us in a crystallized state, are purely chemical bodies, and that identity of name guarantees identity of chemical composition. This illusion is rapidly being dispelled, but, alas! not without having done harm to physicians and their patients. As far as the chemical purity of crystalline products is concerned, it is to-day a secret of Polichinello that crystallized quinine contains cinchonidine, that atropine contains hyoscyanine and atropamine, and that pilocarpine contains jaborandi. As much in organic as in inorganic chemistry we come across this phenomenon of mixed crystallization. The crystallization of substances is no guarantee of their chemical purity. These facts are sufficient to condemn entirely the new therapeutic system that M. Burggraeve has wished to inaugurate under the name of "dosimetric medicine." Dosimetric medicine is doubly on the wrong track—first, in assuming the chemical purity of active crystallized principle of which it exclusively makes use, and secondly, in enunciating the therapeutic heresy that the administration of a single active principle is worth much more than the administration of the drug from which the active principle has been derived. I do not hesitate to describe this dosimetric profession of faith as a heresy. The drugs that are most used are admirably made compositions in which different principles, working for or against each other, are found together. Their therapeutic effect on the system is altogether different from the effect that would be obtained by adding and subtracting the therapeutic effects of each ingredient. Recent pharmaceutic researches have conclusively demonstrated this fact. I do not wish to say too much against domestic medicine. I think it has been, on the whole, inoffensive. Alas! I cannot say as much of the unreasonable faith which leads persons to believe that similarity of name and of active principle in crystalline form will produce chemical and pharmaceutical identity. *Ingentem, regina, jubes renovare dolorem!* We all know the grievous results that may be caused by giving aconitine or digitalin derived from different sources. Here again the progress of chemistry promises improvement. The animal organism is most sensitive to stimulus, and modern chemistry has so many methods of stimulus at its disposal that the task will not be too arduous. It is a question which interests all civilized countries, which is brought forward at all medical and pharmaceutical international congresses, and which is in most urgent need of a satisfactory solution.

### THE VAGARIES OF MODERN PHARMACY.

The services rendered by chemistry to therapeutics is not an exhausted subject. Certainly our predecessors already possessed a goodly medicinal treasury, but it seems very insignificant when compared with what we now utilize. Chemistry has loaded materia medica and pharmacology with wealth; it is the mother of new remedies, and we are proud of its aid; it has given us our anæsthetics, antiseptics, hypnotics, and antipyretics. These groups of remedies enable us to give relief in many cases where our forefathers were quite helpless. To them chloroform, ether, carbolic acid, iodoform, creosote, chloral, the salicylates, antipyrin, were all alike unknown. But here, again, and more so than with respect to the alkaloids, there are shades in the picture.

Chemists and chemical manufacturers add more and more to our store of remedies day by day without stint or truce, without heeding the great despairing physician already overstocked with drugs. We are tempted to cry out for mercy. This is no exaggeration, for these new chemical products are all forced upon the same therapeutic market under the most attractive names, and all proclaimed aloud with the noise of the most perfect advertising machinery. This is now done to an extent that, in my opinion, is detrimental to the interests of therapeutics. I am not speaking of quack remedies, the ovietara of our day, of those secret specifics which the medical man views with wholesome horror, to which, and to whose use, the old adage, *Trompeurs, trompés, trompettes*, can be so well applied. I am speaking of genuine well-known products; for, unfortunately, modern and industrial chemistry, in manufacturing and in placing at the disposal of doctors these drugs, does not at all object to their being purchased by the general public. If this is not so, why do their proprietors select for their names the fascinating names that act as veritable flags to attract the public—for instance, anti nervine, anti-phthisine, anti-rheumatic, anti-dysenterine, and most expressive of all, migrainine. I fully appreciate the difficulty of finding new names for these new products, and can understand that the manufacturer should shrink from giving them the names derived from their chemical composition, for these, generally speaking, could only be pronounced with linguistic gymnastics and intolerable strain upon our memory. I must, with great regret, note that we have departed from the ancient method, which taught us to denominate new products according to their origin, and we have followed freely a course that I cannot blame too severely—that of seeking for euphonious, sonorous names, pompously proclaiming the therapeutic use and effect of the drugs designated by them.

It is not sufficient nowadays to have a good remedy—say agathine—we must be assured of its superlative excellence, hence aristol. Do you want to prescribe for a patient who is "out of sorts," you have euphorine; for a lack of appetite, you have orexine. You desire to procure sleep for him: you have hypnal, hypnon, somnal, or somniferine. You wish to lower a febrile temperature: do not let the emergency trouble you, for you have antipyrine, antifebrine, antithermine, thermomine, thermofugine, pyrodine, and thermodine. You want to assuage pain? *Eh bien*, you have awaiting your orders analgesine, analgeine, exalgine, exodyne, and neurodyne. Or you desire to stimulate urinary secretions, you have diuretine, pheduretine, and uropheine. To check the formation of pus there is a remedy termed pyoktonine; and to combat spasms antispasmine. I do not wish to exhaust your patience and I will spare you the enumeration of the antiseptics, the disinfectants, the microbidines *e tutti quanto*. Ten years exactly have elapsed since my honored colleague, Prof. Rossbach, of Jena, published an article full of wit and sound sense in ridicule and blame of these tendencies of modern therapeutics, and in those days we had not the long lists of antiseptic and antipyretic remedies. Nor was it then imagined that the essential extracts of the organs of animals, of which the late Prof. Brown-Sequard and M. C Paul were the earliest to explain the therapeutic value, would find a place in materia medica, nor cultures of microbes. It was not foreseen that we should have to chronicle in 1894 the sale not only of sequardine, but also of veritable bacterial products such as tuberculine, tuberculocidine, antituberculine, antitoxine, *κ.τ.λ.* How shall we check the fury of this flood? There seems no reason why it should ever come to an end.

## CHEMICAL NOTES.

FROM *Nature* we learn that a series of compounds of sugars with mercaptans, the sulphur alcohols, of a nature similar in many respects to that of the recently isolated glucosides formed by the combination of ordinary alcohols with the sugars, are described by Prof. Emil Fischer in the current *Berichte*. These new substances differ from the glucosides of the alcohols in their constitution, however, for they contain two equivalents of the sulphur alcohol to one equivalent of the sugar; hence they are more nearly allied to the similarly constituted compounds of mercaptans with ordinary aldehydes. The members of the series fully described are the ethyl mercaptals of grape sugar and of galactose, and the amyl mercaptal of the former. In addition to these Prof. Fischer has isolated the ethyl mercaptals of mannose, arabinose, rhamnose and *a*-glucoheptose, and has qualitatively proved the generality of the reaction for xylose, maltose and milk sugar. The compounds appear likely to prove of very great importance, for their formation occurs so readily that they will serve admirably in many cases as valuable aids in the identification and isolation of either the well-known or newly-discovered sugars. The amyl compound in particular appears likely to be of great service on account of its slight solubility. They are all substances of considerable stability and crystallize well. Glucose ethyl mercaptal, $C_6H_{12}O_5(SC_2H_5)_2$, is prepared by mixing ethyl mercaptan with an ice-cold solution of grape sugar in fuming hydrochloric acid. Upon cooling, after the slight rise of temperature which accompanies the reaction, crystals of the new compound separate, and may be advantageously recrystallized from absolute alcohol. The reaction is simply an addition of two molecules of the mercaptan to one of glucose with elimination of a molecule of water.

$$C_6H_{12}O_6 + 2C_2H_5SH = C_6H_{12}O_5(SC_2H_5)_2 + H_2O.$$

Glucose ethyl mercaptal crystallizes in colorless needles and plates, which possess a taste very different to that of sugar, being disagreeably bitter. The crystals melt at 127°, and the liquid may be partially distilled at a higher temperature. The substance is only slightly soluble in cold water and the solution is lævo-rotatory. It behaves as a weak acid, and it is somewhat remarkable that alkalies dissolve the crystals in large quantity, and upon the addition of a dilute acid the compound is precipitated. Indeed, the sodium salt, $C_{10}H_{21}S_2O_5Na$, has been isolated in well defined crystals by treating the compound with sodium dissolved in methyl alcohol. That the substance is very different in its nature from the original glucose is further evidenced by the fact that it does not reduce Fehling's solution. The other members of the series appear to be characterized by similar but graduated properties, the solubility, for instance, diminishing as the homologous series of mercaptans is ascended.

Chloraurate of silver, $AgAuCl_4$, an interesting compound of the very soluble and deliquescent chloride of gold with the particularly insoluble chloride of silver, is described by Dr. Hermann, of Aschaffenburg, in the same number of the *Berichte*. This compound has formed the object of previous unsuccessful researches, but its preparation is very simple when the necessary conditions are known. Four parts by weight of metallic gold are dissolved in aqua regia, and the solution evaporated over the water bath, until upon cooling the resulting chlorauric acid, $HAuCl_4$, crystallizes. One part by weight of silver dissolved in dilute nitric acid is then added, when silver chloride is precipitated in its usual form. Upon repeated evaporation of the whole with concentrated nitric acid containing a trace of hydrochloric acid the silver chloride changes, becoming colored bright red, and eventually is completely converted into a mass of crystals of silver chloraurate. The crystals are long prisms terminated by pyramids and dome faces; they appear to be colored bright orange red when singly examined by reflected light, but are pure yellow by transmitted light, and the finely powdered substance reflects bright yellow light. It is interesting to note that when inclosed in a sealed tube containing perfectly dry air the compound is quite stable and unaffected by bright sunlight, but the moment it is exposed to sunshine in ordinary moist air it commences to bronze, and eventually becomes superficially coated with a dark bronze metallic coating. Dilute hydrochloric acid instantly decomposes it with formation of silver chloride and a solution of chlorauric acid. Ammonia, on the other hand, decomposes it with production of the usual ammoniacal solution of silver chloride and deposition of fulminating gold.

## ANAMORPHOSES.

OUR readers are assuredly acquainted with the silvered cylinders sold by opticians and that permit, through reflection, of rectifying the distorted figures

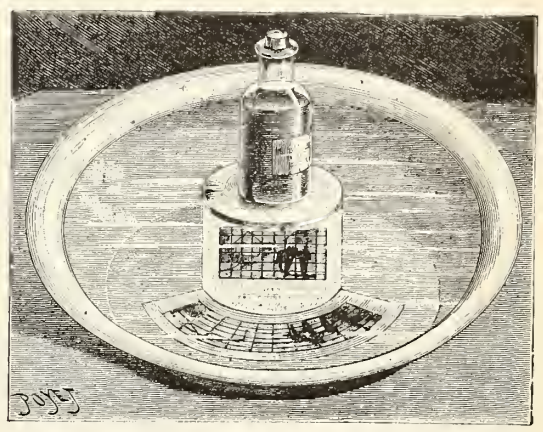


FIG. 1.—EXPERIMENT IN ANAMORPHOSIS.

known by the name of anamorphoses. The effects of total reflection may be observed by immersing an inverted glass vessel in water, and a method of obtaining anamorphic images may thus be secured.

Fig. 1 shows the arrangement adopted by Prof. Thomas Estriche, of the Institute of Barcelona. A glass vessel very dry in the interior is inverted in a large bowl with a wide bottom. In order to keep the vessel at the bottom of the bowl, a weight is placed upon it, a bottle, for example, if there is no other object at hand. We thus obtain an anamorphic mirror. The glass vessel appears flattened through the effect of refraction. When it is desired to make use of the glass as a mirror of anamorphosis, figures are placed

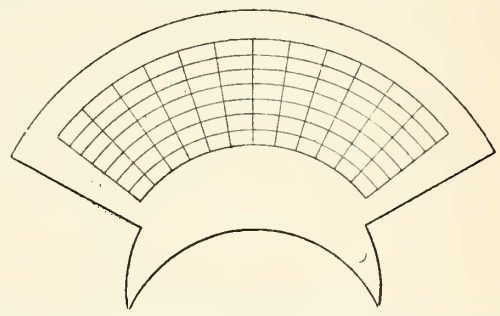


FIG. 2.—OUTLINE FOR MAKING ANAMORPHIC DRAWINGS.

at the bottom of the bowl. As these figures are immersed in water, the paper upon which they are drawn must be rendered impermeable. This is easily done with varnish, or the figures may be painted in oil upon canvas.

Fig. 2 gives the outline that serves for making the anamorphic drawing. If one does not desire to immerse the drawings or paintings in water, he can substitute a large flat-bottomed glass vessel for the bowl. The drawings may be placed under this vessel. They are dry upon the table upon which one operates, and they are observed by transparency through the glass. —*La Nature.*

## TEMPERATURE OF VISIBILITY.

AT a recent meeting of the Physical Society, London, Mr. P. L. Gray, B.Sc., A.R.C.S., read a paper "*On the Minimum Temperature of Visibility*," describing experiments made to find the lowest temperature at which bright or blackened platinum becomes visible in the dark. The instrument used was a Wilson and Gray's modification of Joly's meldometer, in which a thin strip of platinum about 10 centimeters long and 1 centimeter wide is heated by an electric current. The expansion of the strip is indicated by an optical method, and is used for estimating the temperature of the strip. To calibrate the arrangement, small particles of substances having known melting points were placed on the strip and observed through a microscope, the position of the spot of light showing the expansion being noted when the substance melted. The general conclusions arrived at are:

1. That the minimum temperature of visibility is the

same for a bright polished surface as for one covered with lamp black, although the intensity of radiation in the two cases may be different.

2. That the visible limit at the red end of the spectrum varies greatly for a normal eye, according to its state of preparation Exposure to bright light diminishes the sensitiveness of the eye, and darkness increases it.

3. That for the less sensitive condition the minimum temperature of visibility for the surface of a solid is about 470 deg. Cent., but this may be much reduced by even a few minutes in a dark room.

4. That at night a surface at 410 deg. Cent. is visible, and that by resting the eyes in complete darkness this may be reduced to 370 deg. nearly.

5. That different people's eyes differ somewhat in their "minimum temperature of visibility," but probably not to any great extent, if tested under the same conditions as to preparation, etc.

To most observers the strip at these low temperatures had no appearance of red, but looked like a whitish mist. Inserting a plate of glass or a layer of water in the line of vision had no effect on the temperature of visibility.

Mr. Blakesley inquired if the author had tried condensing the light from the strip. As to colorlessness, he observed that the parts of the retina active in oblique vision were less sensitive to color than the central portions.

Dr. Burton remarked that in the experiments the presence of light, and not color, was being observed. When illumination was faint, as in twilight or moonlight, it was very difficult to distinguish colors. In the solar spectrum one did not see any whitish termination at the red end.

Mr. Elder said Captain Abney had shown that all colors appear gray when of small intensity.

The president thought the question as to whether visibility depends on wave length or on energy was an important one. Probably a minimum amount of energy was essential. At such low temperature the emission curves of the different wave lengths may not have become sufficiently separated to be distinguished.

Mr. Gray, in reply, said Professor Langley had shown that a minimum, but very small, amount of energy was necessary to vision in all parts of the spectrum.

## PROBLEMS OF LIGHTING.*

THE eye perceives lights of peculiarly different intensities. With my photometer, founded upon the law of the luminous loss of phosphorescent sulphide of zinc, I have recently determined the least amount of light that the eye can perceive. It is 29 billionths of a candle at a distance of one meter or one candle at a distance of 5·872 kilometers. It is a value comprised between the numbers obtained by other observers with other methods. If it be admitted that the brilliancy of the sun is fifty thousand times that of a candle at one meter, and if the minimum perceptible brilliancy be taken as a unit, it will be seen that the eye is capable of comparing lights varying between about one and one trillion.

The eye is not always capable of looking at the sun with impunity. Plateau was rendered blind by directing his eyes at it fixedly.

For some years past brilliant lighting has been the fashion, and, for the last century, lighting has followed a continuous progression. The mirror hall of the palace of Versailles, which, in 1745, received but 0·19 of a candle per cubic meter, received, in 1873, 0·43 of a candle, and, in 1878, 0·85. It would seem as if there were here an indication of that evolution of the sensitiveness to strong sensations that we find in other domains —the auditory sensation, for example. We know that for a century past all tuning forks have been tending to the sharp, and it is in order to react against such tendency that in France the *la* has been fixed at 870 vibrations.

The intense electric lighting of railway stations, large stores, etc., is not without danger to the nervous system. It causes a weakening of the hearing, insomnia, and digestive disturbances. Under the influence of such lighting, headaches, dimness of vision, paralysis and anæsthesia of the left side have been found in nervous and arthritic persons. An insufficient lighting causes dilation of the pupil, hyperæsthesia, etc. There is a just medium. The illumination of a well exposed surface effected by ordinary daylight is estimated at 50 candles at a distance of one meter. In order to read and write without fatigue, there is required a light of at least 10 candles at one meter.

The following are a few mean lightings that merit comparison:

BOUGIE METER.

| | | | | | |
|---|---|---|---|---|---|
| Rue Royale | 1·28 | =1 | candle at | 0·89 | meter. |
| Rue de la Paix | 1·20 | =1 | " " | 0·91 | " |
| Place de l'Opera | 0·559 | =1 | " " | 1·34 | " |
| Avenue de l'Opera | 0·344 | =1 | " " | 1·70 | " |
| Rue du Quatre Septembre | 0·344 | =1 | " " | 1·70 | " |
| Boulevard St. Jacques | 0·235 | =1 | " " | 2·08 | " |
| Jardins de l'Observatoire | 0·013 | =1 | " " | 8·77 | " |
| Full moon in Sologne | 0·272 | =1 | " " | 1·92 | " |
| Diffused light of the stars | 0·00057 | =1 | " " | 41 | " |

I calculated the first five numbers by converting into ordinary bougies meter ($\frac{1}{8}$ carcel meter) the numbers estimated in *lux* ($\frac{1}{10}$ carcel meter), which Mr. Palaz indicates in his *Traité de Photometrie Industrielle*. They are due to the engineers of the Parisian Gas Company and relate to lighting by gas. They were obtained with the Mascart photometer, while the last four were obtained with my photometer, especially designed for the measurement of feeble lights.

In Mascart's photometer, a general view of which is given in Fig. 1 (No. 2), the light is received upon a Foucault screen, E (Fig. 1, No. 1), of fine paper, and is then reflected by a mirror, M, inclined at an angle of 45°. The whole is mounted upon a horizontal tube, T, and the screw is capable of turning in all directions. At L there is a movable diaphragm against which is placed a lens, F, situated at a distance from the screen double that of its principal focal distance, and which produces an image of the first screen, E, upon a second screen placed behind the total reflection prism, P, and upon the passage of the luminous pencil at the extremity of the large tube, T. The Pigeon kerosene lamp, S, the height of whose flame is regulated by projecting it upon a piece of ground glass, *e*, provided with reference marks, sends upon the Foucault screen, E', a pencil of light concentrated by a lens. This pencil afterward traverses the second movable diaphragm, L, and then the lens, F', and is reflected by the mirror, M', and the prism, P, upon the second half of the screen at the extremity of the large tube, T. A lens, O, allows this screen to be distinctly seen, and a diaphragm, R, composed of colored glasses, permits of equalizing the tints to be compared.

The diaphragms are opened and closed at will by means of buttons placed at the exterior and beneath the tubes. We know from a theorem, often applied since the time of Bouguer, that if, with a converging lens, we form a real image of a luminous source and

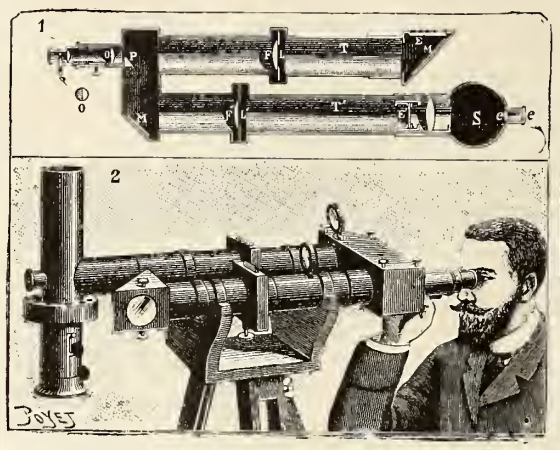


FIG. 1.—MASCART'S PHOTOMETER.
1. Section of the apparatus. 2. General view.

cause the aperture of the objective to vary by a diaphragm, the illumination of the image will be proportional to the surface of opening of the diaphragm, provided such opening be always very small with respect to its distance from the luminous source.

Let us suppose that the receiving screen be lighted by a carcel lamp at one meter. In order to have two identical lights at O, it will be necessary to open the two diaphragms by a certain number of divisions. These latter are read at the exterior by means of two lenses without the eye leaving the plane of observation. Let N' be the number of divisions on the side toward the lamp of comparison, and N the number of divisions on the side toward the receiving screen of the light of one carcel at one meter; the relation $n_0 = \frac{N'}{N}$ will be a constant of the apparatus to be determined once for all. In another experiment, with another illumination, we shall have another N', say $N'_1$; whence another relation, $n_1 = \frac{N'_1}{N}$. The quotient $\frac{n_1}{n_0}$ gives the value of the illumination in carcels meter in the second experiment.

It is evident that with a view to the measurement of very brilliant lights, we can take a light of a much greater intensity than one carcel as a unit. It suffices to render the receiving screen, E, more opaque and the screen, E', less so. For the measurement of feebler lightings, the screen, E, would be rendered more translucent, and the screen, E', would be made more opaque.

Nevertheless, for very small openings of the receiving screen, the error committed in the reading of the graduation, and which is expressed by a fraction of a millimeter sensibly always the same, represents a necessarily large fraction of the quantity measured. There is here, imposed by principle, a limit of precision that it is impossible to surmount. This is why I have had constructed, especially in view of very feeble lights, a photometer founded upon the law of luminous loss with time, of phosphorescent sulphide of zinc.

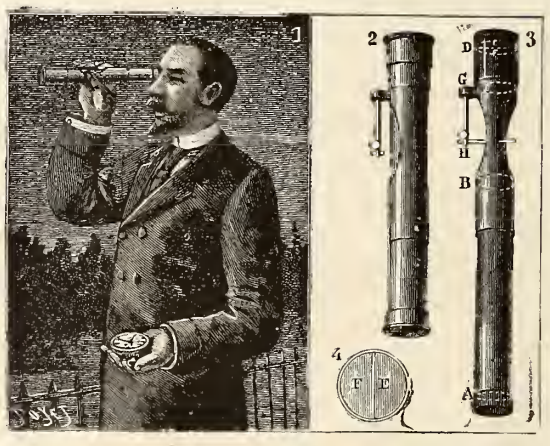


FIG. 2.—HENRY'S PHOTOMETER.
1. Method of using the apparatus. 2, 3, and 4. Explanatory figures.

This very simple apparatus (Fig. 2, Nos. 1 and 2) consists of three connected tubes blackened internally. The one that is applied to the eye is provided with a converging lens, A, of great focal distance, the object of which is to suppress the sides of the tube from the field of distinct vision. This tube slides within another provided with two ellipsoid slits, one at the top and the other at the bottom.

A magnesium ribbon 0·003 meter in width, about 0·15 meter in length and 0·0001 meter in thickness, suspended from an arm, H, is designed to burn in this space isolated from the interior of the apparatus by two protecting glasses, B and G. These dimensions of the ribbon suffice to give the sulphide a maximum illumination.

Upon this central tube is screwed externally a tube terminating in two semicircular screens, E and F (Fig. 2, No. 4), separated by a perpendicular partition. One of them, composed of ground glasses of a greenish yellow color identical with the phosphorescent tint, and for which, in view of very feeble intensities, there may be substituted any less absorbent screen through the simple play of a ring, receives the external light. The other is covered with sulphide of zinc.

The posterior tube is separated from the front one, the magnesium ribbon is lighted and the time at the moment of extinction is noted. The posterior tube is replaced against the anterior one, and the time is noted at which there is an equality in the light of the two screens.

On giving the value 100 to the light of the sulphide at the end of 85 seconds—a light equal to the illumination of the translucent screen by one candle at 3·75 meters—there have been found for the lights, at the different times, values that are the ordinates of the curve shown in Fig. 3. Knowing with all precision possible the time at the end of which there is an equality of light between the phosphorescent screen and the translucent one, we take the corresponding ordinate upon the curve of the observations at the time indicated by the chronometer and marked upon the abscissa. This is referred to any ordinate whatever expressed in bougie meter, and we immediately have the brightness of the source in fractions of bougie meter. It is in this way that I have been able to measure the light of the full moon, and of the points of the sky opposite the moon, etc.

For more precision in the measurement of feeble lights it is well to make use of a curve constructed upon a large scale.

The greenish color of the sulphide, far from being prejudicial to the precision of the observations, contributes much to it, since, according to a well-known law, as the phosphorescent screen is less luminous than the translucent one, it appears bluish, and the other yellowish.

For the equalities of tints that are produced before 1,400 seconds, the curve of the observations is immediately utilizable. For the feebler lights the most convenient way to proceed is to apply one of those formulas called asymptotic, that reproduces as faithfully as possible the last observations, and consequently offers a guarantee of being true much farther.

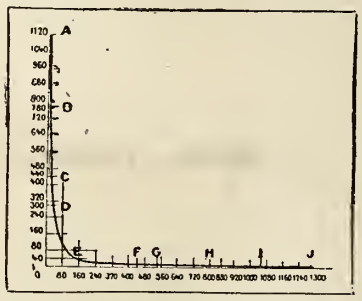


FIG. 3.—CURVE OF LUMINOUS LOSS OF PHOSPHORESCENT SULPHIDE OF ZINC.

It is by the extrapolation of this formula warranted by considerations of mathematical physics that I determined the diffused light of the stars on August 22, 1892 (0·0005704 bgm.) and the minimum of luminous intensity perceptible.

This apparatus may be used also, thanks to a few very simple complementary arrangements, for measuring the absorption of chemical rays by liquids, fluorescence, the richness of light in chemical rays, etc.

For the purposes of photoptometry (measurement of luminous sensitiveness) I have had constructed, by Mr. Rodiguet, a photometer founded like that of Mr. Mascart upon the principle of the diaphragming of objectives, and the luminous source of which is a screen covered with phosphorescent sulphide of zinc. This apparatus gives very rapidly, and with a precision impossible to obtain with ordinary lights, the minimum perceptible.

Just as there are consonances and dissonances, just so there are juxtapositions of luminous intensity that aid or injure the eye, and that produce relative anæsthesias or hyperæsthesias of the retina. Such modifications of the nervous system can be explored by varied methods and be characterized by numbers. The object of all sumptuous lighting is to create harmonies of light. This result, which would be so urgent to realize in ordinary lighting, is not, as a general thing, reached. The eye is always injured in drawing rooms and in the great, fashionable halls by the multiple reflections of the dazzling whites and of the gildings, or by the incoherence of the arrangement of the usually identical sources of intensities. People content themselves with recalcitrating, and forget that for strong excitations our sensitiveness varies much less quickly than does luminous intensity.

It is not very convenient to experiment upon a large number of mean luminous intensities in given ratios. Such experiments are costly and cumbersome, but it is easy to realize harmonies of lights and to verify the law of them with feeble intensities like those given by phosphorescent sulphide of zinc.

It suffices to operate upon layers of unequal thicknesses, like those that I have obtained by a typographical impression in my *Lavis Lumineux*, or upon layers of the same thickness that are illuminated at different instants calculated in advance. The sulphide of zinc permits of managing the light with as much facility as the printer or the painter manages any sort of pigment.

Physiologists have long observed that a certain time is necessary and sufficient for the integral perception of a light. Such time is shorter when the intensity is greater. What is such duration when the intensity is the least that is perceptible, like that of the light of a

* Continued from SUPPLEMENT No. 951, p. 15202.

beacon at the limit of its luminous range? It may be estimated at $\frac{1}{10}$ of a second. This observation has led to a remarkable innovation in the lighting of our beacons. For the apparatus making an entire revolution in eight minutes and giving flashes of a duration of eight seconds there are substituted optical apparatus of two lenses, at the most, making a revolution in five or ten seconds and giving flashes of a tenth of a second. It has thus been possible to greatly increase the power of the lights, and attain intensities of twenty-three million candles without augmentation of expenses and without an addition of motive power.

There are no problems more varied, more complex, more practical, and more happily treated in recent times than those of lighting.—*Charles Henry, in La Nature.*

## HINTS ON COLORING LANTERN SLIDES.

By GEO. M. HOPKINS.

IT frequently happens that one who is practiced in the art of coloring lantern slides desires to color a rare or valuable slide when the remotest chance of injury to the slide cannot be taken. In such cases the color must be applied either to the back or outer surface of the plate or to a plate that will answer the purpose of a cover glass. The latter method is certainly to be preferred, as it involves no risk whatever, and at the same time affords an opportunity of trying different color effects on the same picture; such for example as spring, summer and autumn tints in landscapes, and different combinations of color in architectural views, interiors or figures.

The plate used for receiving the color is an old unused gelatin lantern slide plate, from the film of which the silver has been removed by hypo; or a gelatin plate from which a discarded view has been removed from the film by means of a reducing solution; the plate in either case being washed long enough to remove all hypo.

The film on the unused plate will need toughening by soaking it for two or three minutes in a solution of alum of the strength commonly used for preventing frilling, the plate being afterward thoroughly washed. This plate takes color better than one which has been subjected to the reducing process. A plate may also be prepared by flowing a solution of gelatin over a clean cover glass, allowing it to dry, and then treating it to an alum bath and subsequent washing.

LANTERN SLIDE COLORING.

The slide to be colored, which is, of course, unmounted, is placed with its glass side against the glass side of the transparent film-bearing plate, which is dry, and the transparent film is wet all over by means of a very soft brush carrying clean water. Some caution is required to prevent the film side of the slide from becoming wet. A small quantity of water absorbed between the contacting glass surfaces is an advantage, as it binds the plates together and prevents them from moving easily one on the other.

The coloring is done upon the transparent film, following the outlines and every feature of the picture as closely as possible. It will, of course, be impossible to follow every leaf and blade of grass, or every twig and flower, with perfect accuracy, on account of two thicknesses of glass intervening between the color film and picture film, yet the results secured by this method are astonishing. The writer has colored slides in this way which were not distinguishable, even by experts, from slides colored on the picture-bearing film. The following description of a method of coloring prints on gelatin-coated lantern slide plates is taken from the writer's article in the SCIENTIFIC AMERICAN of March 11, 1893, it being applicable in the present case:

The first operation in coloring is to go over the entire surface of the film while it is wet with a thin wash of warm color, which may be either yellow or pink, depending upon the subject. This kills the chalky whiteness of the high lights, and gives the entire picture a warm and desirable tone, even though the wash is not sufficiently strong to be detected when the picture is thrown upon the screen.

The colors used for this purpose are transparent aniline colors prepared for coloring photographs. They are labeled brown, blue, violet, flesh, orange, green, and so on. The ordinary aniline dyes may be used instead of the prepared colors, as they are practically the same. The manipulation of the colors is the same as in water color painting. The film is kept wet continually from the beginning to the end of the operation, but after the broad washes of the first warm tint and the final sky color, the water lying on the surface of the film is allowed to dry off, leaving the film still swelled and wet, but without the surface water.

The prepared colors can rarely be applied to the slide without being reduced with water. Sometimes the best effects are produced by mixing different colors before applying them, while in other cases the effects are secured by separate washes of different colors, superposed. Each wash of color sinks into the film and is not removed by a subsequent wash.

Although an easel or support something like a retouching frame may be useful, the writer prefers to hold the slide in the hand, as shown in the engraving. The wet plate is held in a slightly inclined position in front of a lamp provided with a plain opal or ground glass shade. The writer prefers artificial light for coloring, as the pictures are to be shown generally by artificial light, which is yellow. If the pictures are designed for projection by sunlight, it is undoubtedly better to color them in daylight.

The first wash is preferably put on while the slide is held in an inverted position, and while it is still flowing the blue is added for the sky, at first very light near the horizon, increasing in intensity toward the top of the slide. After this wash is set and superfluous water has evaporated, the water accumulating along the lower edge of the plate is removed with the fingers, and the slide is turned right side up, when the extreme distance, whether it be mountain or foliage, is covered with a light wash of blue, and this wash is brought well down toward the foreground. If the blue appears cold, it can be toned down by a very light wash of yellow or red. Trees in the middle distance can now be gone over with a light wash of orange or orange with a little of the flesh color or pink added. When near the foreground a very light wash of green is applied to the foliage, but the raw green of the color set cannot be used for this; it must be modified by the addition of orange or of brown. If when applied the green appears too cold, it may be toned down by a light wash of brown, or orange or flesh color. It is desirable to produce variety in the foliage.

Rocks in the distance are washed with blue and the color is subsequently modified by washes of red or brown. Trunks of distant trees and some rocks may be left nearly the original color of the photo., but near rocks and tree trunks may be tinted with brown, blue, or warm green, and subsequently modified by washes of green, red, brown, yellow, or orange.

It is useless to trace the smaller branches of trees and shrubs, and it is rarely necessary to deal with single leaves or blossoms; when this must be done a jeweler's eyeglass is required, and fine, small brushes are used, great care being taken to keep within the outline of the object being colored. In all this work, the artist does well to remember that the coloring is to stand the test of great magnification and strong light.

The plate is apt to dry out in some places while the coloring is going on at other places. As coloring cannot be successfully done on a dry surface, it is important to wet the surface before proceeding. This is done by applying water with a soft camel's hair brush. After the surface water has disappeared the coloring may proceed.

It is obviously impossible to mention every modification of color that may be produced by mixtures and washes. This is something to be acquired by practice. The writer uses very few colors, rarely more than the following: Blue, green, brown, orange, flesh, rose, and yellow. The last is a strong color, which must be applied with caution. Green and blue are also strong colors, which can never be applied without the admixture of a warm color, or a subsequent wash of the same. Brown in different strengths has a large application. It is useful in toning down bright greens, for rocks, tree trunks, earth, etc. A wash of blue over the brown produces a different but useful gray.

The principal points to be observed are to keep the plate always wet, to use light washes, to modify color by subsequent washes, and in working up details to preserve the outlines.

After the coloring is completed, the glasses are separated, the colored film is allowed to dry, when it is placed over the picture, the two films being in contact, and a binding strip is attached to the edges in the usual way. The mat in this case is pasted on the outside of the cover.

When it is desired to color a wet plate or collodion film slide with liquid colors, the collodion film is coated with a thin transparent film of gelatin, which is allowed to dry, when it is immersed for a few minutes in a solution of alum, to toughen it. It is then washed, and while still wet, the broad washes of color are applied.

Something has been said about the permanence of the liquid colors used on the slides. The writer has many slides colored in this manner two or three years since, which have not changed perceptibly. Without doubt, continual exposure to sunlight would affect them, but it would also change any other colors used for this purpose. In a prolonged test in sunlight of all the liquid colors used on slides, it was found that the greens after a time turn yellow. Brown becomes somewhat darker. The reds and yellow remained unchanged. Blue faded slightly. But this is a test more severe than colored lantern slides would ever be subjected to. The writer believes they would retain their color indefinitely.

## INFANTRY FOOTWEAR.*

By Lieut. NAT P. PHISTER, First United States Infantry.

IN considering the great number of things which contribute in a greater or less degree to the success of an army in any series of operations which may be undertaken by it, we find that every turn that we are confronted by some problem involving transportation. Assuming that all soldiers will fight equally well when actually confronting the enemy, there still remains the question as to how an advantage is to be obtained by placing in opposition to that enemy, at the most effective place and time, a force sufficient to oppose him successfully.

Whatever we may have done, or may in future succeed in doing, to increase the facilities for the rapid movement of large bodies of troops by rail or otherwise, the whole history of the art of war shows us in unmistakable terms that we can never afford to ignore the immense advantages which an army may derive from a superiority in the marching power of its infantry; and this applies with equal force to the speed in tactical maneuvers which rapidly shifts the weight to suit the event, in the hurry and turmoil of the battlefield, and to the power of sustained endurance which will, in the strategical operations of a long campaign, inevitably give a superiority to the best marchers, if other conditions are approximately equal.

Reason and precedent justify us in assuming that marching power, including in the term both speed and endurance, must always remain a prime factor in the determination of success.

The veteran of the Imperial Guard who, while on the march in one of Napoleon's rapid strategical combinations, remarked to a comrade, "The 'Little Corporal' fights with our legs in this campaign," stated a truth which, generalized, would have a wide application in the history of war.

Preparation for war must always consist in the painstaking elaboration of innumerable details, and in the proving and improving, in peace, of the many small means contributing to the great end in view. It is my purpose herein to call attention to one of these contributory means, and to attempt to show the proper direction to be taken in the steps necessary for its improvement.

Every man who has marched at all knows that footwear is, even for the unladen marcher, of the utmost importance; and this is more apparent in the case of the soldier in campaign, who marches in all kinds of weather, burdened with his wardrobe, means of shelter, ammunition and weapons. Leg weariness wears off in a few days' tramping; the pack, so heavy at first, becomes lighter by the adaptation of the muscles to its presence, as well as by the abandonments which will surely result from the bearer's simple balancing of values between carriage and possession when at rest; but a cramped or chafed foot, in the bad shoe or stocking which caused the injury, does *not* get better with increased misuse.

If we wish to march men well, far and rapidly, or to keep them steadily going, day after day for a long time and at a telling gait, we must look to the welfare of their feet.

They should be carefully instructed how to take care of their feet to keep them sound, of course. A hygienic discussion offers a tempting field here, but it is not necessary for the purpose of this essay. Considering soldiers simply as machines, and assuming the fuel and water supply to be properly cared for, their legs will hold out if their feet will. It should never be forgotten that the mere presence of troops at a given point at a given time, however opportune, may have no value unless they are in a fit condition for the rapid marching which is nearly always necessary in making tactical dispositions for battle, and that the demands upon their speed and endurance do not cease even when a battle is won, for pursuit should confirm success.

In considering nature's means of transportation for the individual man, we find that the feet are the portions of the machine subjected to the most constant strain and to operation of external wear, and that whatever strengthens the machine or protects it from wear at this point contributes directly to both speed and endurance.

Let us then consider what are the requirements which, if complied with, will give us the desired increase in ease and power, so far as that increase may be derived from improvement in footwear.

1st. Protection from wear. 2d. Freedom of action for the foot. 3d. Lightness. 4th. Flexibility of the shoe. 5th. Fit.

The above numbers have no reference to the relative importance of the several requirements named, which are so co-ordinated that such a classification is practically impossible. The separation is only made for convenience of discussion, and the requirements are for stockings as well as for shoes.

* Graduating essay at the United States Infantry and Cavalry School.—*Journal of the Military Service Institution.*

1*st. Protection from Wear.*—The first protective article of footwear devised by man was probably the sandal. It really protected from undue wear, and from injury by the roughness of the ground, only the sole and the lower parts of the sides of the foot.

It was then an insufficient protection, but as far as the other requirements are concerned, its excellence cannot be questioned; and if we compare it with the sole of the modern shoe of which it is the prototype, we shall find that, however much we may have improved as to material, we have certainly retrograded as to shape. The upper has simply been added to the original sole to give protection to the upper portion of the foot. The sole must be heavy and compact to stand the wear from the ground, while the upper, having no great wear except by its own bending, may be quite light.

2*d. Free Action from the Foot.*—It is not necessary to go into the anatomical structure of the foot. Any reader may look at his own feet and consider them illustrative examples of the remarks herein made.

The structure and action of the arch and forward portion of the foot show plainly that it is intended to be used as a flexible, elastic, weight-bearing structure, and that anything which impairs its elasticity and flexibility must interfere to that extent with the proper performance of its natural functions.

Any one must admit that it is a plain violation of nature's laws habitually to cramp, imprison and distort any portion of the human frame, and yet as to the foot, we differ from the Chinese women only in degree. Not one adult in a hundred has any power to separate his toes when barefooted—but all babies have it.

A fair average width for the weighted foot of a medium sized man, measured across the ball, is about four inches. Measure a number of the soles at this point and you will find the average much less. In other words, the shoemaker expects either to cramp the wearer's foot down to the size of the last or to have his foot project over the edge of the sole from one-half to three fourths of an inch. The spring of the weighted arch lengthens the foot and the forward part of the foot spreads laterally; hence to fulfill this requisite we must make the sole as long and as wide as the weighted foot, and we must have no undue constriction by the upper. Can you imagine a Roman soldier or an Indian cutting his sandals narrower or shorter than the extreme measures of his weighted foot? I think not.

3*d. Lightness.*—It is, or should be, plain that the shoe should be as light as is compatible with the fulfillment of the first two requirements.

Most shoes intended for standing much continuous wear are made far too heavy, particularly so as to the uppers. Uppers cut from good heavy calf skin (say 5 or 6 pounds to the skin, depending on size) are heavy enough for any wear, and for that part of the shoe about the ankle there can be no objection to the use of much lighter material, such as canvas-lined sheepskin (the so-called "kid" of the trade).

Our cavalry give careful consideration to the weight of their *horse* shoes (weight of troopers' boots is four pounds) and comparing the weight of the foot soldiers' shoes (issued by the Q. M. Dept.) with these horse shoes, it is found that the soldier, whose power is rated at about 1-5 that of the horse, is expected to carry upon his feet a weight considerably at variance with the proportion of power which he develops. A recent comparison of weights resulted as below. So many different weights were given for horse shoes that the weight taken is stated upon the authority of several cavalry experts, who gave it as the proper weight for a full set of shoes for a horse of medium size.

Weight of full set of horse shoes, 48 oz.

Weight of pair of soldier's No. 8 shoes (latest pattern), 40 oz.

Weight of pair of soldier's cavalry boots (latest pattern), 64 oz.

It is as desirable now as in the days of pilum and shield that a soldier should be a trained athlete. The soldier should be a racer. We do not shoe a race horse like a beast of burden, and for the purpose of his business a soldier needs, and should have, the lightest, strongest and best of shoes. If the present shoes are intended to serve the purpose of the double weighted arms of exercise which were used by the old Romans, they are not too heavy; but if they are intended for daily use in actual business by a man from whom speed is to be required, they are far too heavy.

4*th. Flexibility of the Shoe.*—This is only another feature of the consideration concerning freedom of motion, but as it involves more particularly the material and make-up of the shoe, while the former consideration has more to do with its fit, flexibility is considered separately. Assuming from the start that leather is the material to be used, it may be confidently asserted that, weight for weight, there are great differences to be found between the various kinds of leather. Some leathers, notably hemlock sole leather of the usual market grades, are hot tanned, and this makes them stiff, hard and less tough. Cold tanned oak sole leather of proper thickness, and well rolled to make it compact, is eminently desirable in every respect, and, while it costs about one-third more than the hot tanned hemlock sole, it is fully worth the difference.

As to upper leather, it will be found that the tanning has a great deal to do with its quality. It will be found, also, that no such leather is good which does not include the whole thickness of the hide. The middle layer of the tanned bovine hide is fibrous, absorbent and tough, but it cannot be dressed, shaved, rolled, or pressed to a permanently smooth surface, or to any surface which will wear well, and therefore a piece of leather, originally too thick, which has simply been split or skived down to the required thickness, has been so treated at the expense of one of its wearing surfaces, and the surface so exposed is so loose and fibrous in texture that it will not properly retain dressing, rapidly absorbs moisture and soon hardens and stiffens until it will break.

Much of the "upper leather," so called by the trade, is of this character, and it is not, in my opinion, fit to make any part of a shoe to be worn on a human foot. It is obvious that the extra thickness which necessitates splitting accompanies greater age and size in the animal from which the hide was taken, and, therefore, a coarser texture of the hide, which tends to increase the defects spoken of. Our soldiers wear, or have for years worn, shoes made from leather of this kind, and the fuzzy, cloth-like appearance of the leather is familiar to every observant officer. Soldiers call them boiler iron shoes, and they deserve the name.

Lately a move has been made in the right direction by having the shoes cut from "kip" (only a trade name for hides lighter by a trifle than "upper" and sold in the whole hide by the pound; while "upper" is sold in "sides," the hide being cut in half down the back and sold by the square foot), but the reform does not go far enough, as will be seen from the weight of a pair of these "kip" shoes (40 ounces).

To get proper leather, then, we must obtain it by careful selection from such hides as by natural size and thickness (resulting from age and size of the animal) are best suited to our requirements. Well tanned calfskin is the best material to be had, and, though perhaps not so attractive to the eye, grain-dressed calfskin is better for soldiers' shoes than that dressed on the flesh side. A moment's consideration will show why grain-dressed leather is better. The skin of the animal performs excretory functions, and it seems plain that to reverse its position when putting it in the shoe is to invite the entrance of moisture; in addition to this, if the grain is out, the wear is in nature's own direction. Practice has proved the truth of the above, for sportsmen have for years used grain-dressed shoes, and they find them better. The materials mentioned above will give the required flexibility and lightness; they are easily obtainable and should be used.

5*th. Fit.*—From the heel to the forward portion of the arch of the foot the shoe should fit snugly to avoid slipping and chafing, and it may so fit without interfering with freedom of action, because this portion of the foot does not spread, laterally, under weight, though the length of the whole foot on the ground is increased by the flattening of the arch. The shank of the sole may therefore be narrow.

Forward of the shank, the sole should be broad, as already mentioned, and there should be no surplus leather in the upper. I refer here to a very common error made by shoemakers, some of whom seem to think that breadth of foot across the ball must always be accompanied by a corresponding increase in thickness, whereas, with feet of the same length, the converse is nearer true. The whole matter is right here—*fit the weighted foot.* If it were possible to do so, every shoe should be made to individual measure. As this is practically impossible for soldiers, what is the next best way to give them what they need? Evidently such an assortment of sizes as to length, width, etc., as will enable us to go into a quartermaster's storeroom and fit, with a comfortable shoe, any man whose feet are not abnormal in shape or size.

Can this be accomplished? Unquestionably it can.

A good shoe dealer can, from his stock, fit almost any foot (*military* foot not here understood), and there is no reason why the Quartermaster's Department should not be able to fit any soldier's foot. The fact that soldiers' feet are all examined and passed upon by competent surgeons narrows the limits of variation so much that no very great diversity of shapes and sizes would be necessary to meet every demand. It cannot be urged that much stock would be left on hand, for with dimensions fixed between reasonable limits, the law of chances would take care of the rest. Keeping such an assortment pays the dealer, who calculates upon probable diversity and demand with far less certainty than would be possible for a supply department of an army. Go into any large shoe store and they will present for your selection from six to a dozen different widths and shapes of the same style of shoe at the same price.

A few years ago the government spent $10,000 to have an alleged expert go through the army teaching a system of horse shoeing (he and his system are anathema maranatha among our cavalry officers to this day, and the crippled horses have died or been sold—but the money *was* expended). A much less amount, judiciously expended upon and by one of the few really scientific shoemakers in the country (for there are a few who are pretty well known as specialists in their line) would probably result in a vast improvement in military shoes. Such a man, by comparison of data, which could easily be furnished him, or which he could easily obtain, would be able to determine what variations in size and shape would be necessary, and to fix the shapes of a full set of military lasts, which would insure the success of a system by which each individual soldier could be fitted as a shoe dealer fits a customer. The soldier's shoe would be improved in fit, comfort, and utility, provided the system was adopted and that proper materials were used—but we would probably have to abandon some wrongly preconceived ideas as to style.

We may reasonably suppose that the improved shoe would be of grain-dressed calfskin, medium weight, hand-sewed, with a heavy oak-tanned sole projecting slightly beyond the upper, with a flat shank and a low broad heel, with a smooth insole slightly dished at heel and ball; with a wide sole at the ball slightly greater than that of the weighted foot, and with the upper across the ball so cut that there would be no slack leather. The shoe would probably be a half boot shape, lacing with a few holes over the arch and having soft loose tops about the ankle, which would leave the ankle free to develop, as it would, a strength and elasticity proportioned to its work. I do not consider it necessary or advisable to support the ankle by tightly laced leather. The sinew and muscle developed by exercise are the best supports for any part of the framework of a soldier. The sole of this improved shoe would be as nearly as possible the shape of the bottom of the weighted foot, and slightly rounded off at the toe for increased protection to the ends of the smaller toes. A light metal plate at toe and heel would increase the life of the shoe.

Such a shoe would not be pretty or stylish, but it would not hurt the soldier's foot and in it he could march far and fast and come in still fit to move rapidly, provided that his other needs were cared for.

Right here it is proper to speak of a recent article by a French officer upon the subject of the peculiar fatigue resulting from marching. In saying that this fatigue and nervous strain results from the continued rhythmical repetition of a jar, transmitted at each recurrence in the same direction through the same bones, muscles and nerves, this writer has only formulated a principle well known to every man who has marched much; but I do not think much of his remedy, which consists in the use of an elastic cushion under the heel. An American invention, on precisely the same principle, is advertised for the use of nervous invalids, but soldiers are not usually of that class. If we have to deal with a recruit who jabs his heels into the ground, we can correct it. Elasticity of tread comes with practice in marching, and with the strength and proper development of muscles which are its legitimate result.

As to the durability of such a shoe as has been mentioned, it may safely be asserted that with some slight attention from the cobbler, who with some of the simplest tools of his craft and a supply of leather should accompany each infantry company, two pairs of such shoes will, over ordinary roads, wear for 1,700 miles, which is a greater distance than any soldier would probably have to march without an opportunity to renew his shoes. The net cost would be about one half a cent per man per mile. Each soldier should have furnished to him to be cut by the cobbler, after his shoes are well broken to the foot, sufficient sole leather for a pair of slip soles, which should be cut accurately to fit the inside of the shoe. The advantage of these slip soles when on the march is very great; they can be taken from the shoes, beaten together to remove the dust, after being dried in the sun, and then replaced for the next march; thus keeping the inside of the shoe fresh and clean. It is an open question whether one pair of such shoes and a pair of light camp slippers would not be a sufficient supply for the soldier to carry on his person in campaign. Casualties would furnish many opportunities to renew shoes.

It is a little curious, to one who has never thought of it, how the cost of shoe leather foots up, and how easy it is to reach an approximation to the cost by a simple calculation, provided one has, to start with, a few data as to the distance one pair of shoes, of known cost, is good for.

I have made some experiments in my own case as to this, and have above given the result of them and of a careful observation of these matters for about ten years.

As to the issue of a better shoe, of the kind described, to our army, the question of price need not enter the discussion at all so long as the increase is not too great. Such shoes can be made at a cost of $4 per pair, which, considering quality, is no great increase on the present list price ($1.89) of the sewed campaign shoe. For a soldier, a good shoe, like a good rifle, is beyond any paltry consideration as to price.

Another thing should be spoken of here. If a shoe is good enough for a soldier to march in, it is good enough for him to wear at any time when on duty, and nothing but the high class (unstylish) marching shoe should be issued at all, unless the light camp slippers spoken of should be adopted.

Having determined to issue the shoe and having employed our specialist to determine sizes, etc., we would probably have for issue of each size of shoe by length, say nine sizes. For example:

*Shoes No. 6.*

| | High Instep. | Medium Instep. | Low Instep. |
|---|---|---|---|
| Width, | A | A | A |
| | B | B | B |
| | C | C | C |

The number of widths need not exceed three, since the variations in the weighted foot are much less than in the unweighted foot, and besides, we do not consider style as an element of selection.

Taking Recruit Ferguson into a quartermaster's storeroom where all the authorized sizes of shoes are kept, we would have no difficulty in fitting him with a proper shoe. An officer should be present and see to the proper fit of this first pair of military shoes, and there would be no trouble afterward. It would appear on Ferguson's descriptive list that his size was, say, No. 6 medium B, and requisition could be made accordingly; but Ferguson should not be allowed to draw a shoe of different size without first exhibiting to an officer the fault of his last shoes, nor without an officer to supervise the fitting of the new ones.

I have indicated three divisions by height of instep. It is possible that a tabulation of many measurements would show that some other dimension should be made the basis of division, but the principle would be the same. I have only intended to indicate the main features of a system, not to elaborate finer details; for that the services of a scientific shoemaker should be obtained.

I have spoken of a cobbler's wagon. It is a necessity; no forge, forge wagon or battery wagon is so much so. Some arrangement for mending the shoes of the soldiers during campaign should always be made.

So much for the shoe.

A much more neglected article is the stocking. More blistered feet, corns, ingrowing nails and overlapping toes result from ill-fitting stockings than from bad shoes. With the stocking the fault is nearly always the same—narrowness at the toe; and the present issue stockings have it.

The stocking should be of cotton, soft woven, seamless, and shaped like the foot.

A recent writer says, "So unheard of is hosiery of the exact shape of the foot, that some one has recently acquired a patent on it in this country." Comment is unnecessary.

The stocking should be held up so that it will not wrinkle at the heel and produce blisters. A soldier with calves on his legs cannot keep his stockings up properly without garters. Garters are not objectionable if they do not tightly bind the leg, and modern ingenuity has overcome that objection. To complete the comfort and security of the soldier's nether extremities, we have the present canvas legging. It is excellent, and would go well with the proposed shoe, but the pattern might be improved by narrowing the ankle slightly.

It was not intended in this brief essay to write a history of shoes, to compile data as to their use and abuse, or to give a perfect system by which perfect shoes could be procured and issued, but only to point out a few of the essential particulars in which the footwear of our infantry could be improved, and to call

attention to the importance of improving it. No part of the soldier's clothing or equipment is more important. A soldier can and frequently does fight in his shirt sleeves and bareheaded, nor is his military efficiency impaired by a canvas patch on his trousers, but if his shoes give out or his feet get sore he will not be on hand to fight at all. By the failure of the shoes, the man, his arms, and his ammunition are lost for the fight.

During the time I have taken in observing this matter, I have marched about two thousand miles, all told, and have closely observed and questioned the men of my company about their shoes. I have seen about five per cent. of a regiment of three hundred men disabled for hard marching by sore feet, in a march of ninety miles over good roads, going at the rate of about twelve miles per day; and, as a contrast, one company of the eight present in that regiment went through without a sore foot in the entire company, simply because its captain had looked carefully to his men's shoes, and had each man prepared with well broken, well greased shoes of proper size. (It was not required that the men of this company should wear the issued shoes, but no shoe might be worn unless the captain approved it.)

In war five per cent. would be a heavy interest to pay for poor economy.

This whole matter, while worthy of the close attention of all military men, is, comparatively, a neglected field. The subject is a homely one, and has none of the attractive glitter of more pretentious themes, but it is worthy of much thought and deserves a better presentation from some more skilled and facile pen than mine. The great Napoleon hanged a contractor for stuffing soles, and he discovered the fraud by cutting up a shoe with his own imperial hands. Wellington is said to have enumerated the three most essential articles of a soldier's equipment as: 1st, a pair of good shoes; 2d, another pair of good shoes; 3d, a pair of half soles.

The feet of the soldiers of our army are among its most effective weapons, and they deserve and should receive all due care, and the army in which this care is neglected will bitterly regret the omission at a time when it has much more than vain regrets to occupy its attention.

## THE LEGAL RESPONSIBILITY OF THE AGED.

By J. J. CALDWELL, M.D.,* Baltimore, Md.

HISTORY is replete with the failings of old age. The exceptions are rare and stand out like meteors.

"There is a senile dementia, and a form of dementia associated with general paralysis. Dementia also has its degrees and its stages of forgetfulness, irrationality, incomprehension, and inappetency. A patient suffering from dementia, as he passes from bad to worse, first exhibits a want of memory, then loss of reasoning power, then inability to comprehend, and lastly, an abolition of the common instincts and of volition.—P. 50, 'Field's Medico-Legal Guide.'

"In the progress of this mental disorder the mind usually dwells only on the past, and the thoughts succeed one another without any obvious bond of association.

"Delusions, if they do exist, are only temporary and leave no permanent impression, and for anything recent the mind is exceedingly weak. If it occurs as acute dementia in young people, it is generally incurable. In old men, in whom it most frequently occurs, it is called senile dementia, and indicates the breaking down of the mental powers in advance of bodily decay. The persons may become oblivious of names and dates."

Professor George M. Beard, now deceased, the great neurologist and electrician of New York City, and author of an elaborate work on these subjects, has divided a paper read before the Medico-Legal Society of New York into three heads, viz.:

1st. What is the average effect of old age on the mental faculties? In other words, what is the law of the relation of age to work?

2d. To what extent is the average responsibility of men impaired by the change which the mental faculties undergo in old age?

3d. How shall the effects of age on the mental faculties be best brought to the attention of our courts of justice?

These questions have been a life-long study with this scientist, who set about making his investigations without fear or prejudice, and in the full hope that the result of his researches would be made available in deciding the condition of the minds of men past the full maturity of life.

Dr. Beard has deduced these general results from his prolonged investigations, viz.:

| | | | | | |
|---|---|---|---|---|---|
| The golden decade is between..... | | | 30 | and | 40 |
| The silver | " | " ..... | 40 | " | 50 |
| The iron | " | " ..... | 50 | " | 60 |
| The tin | " | " ..... | 60 | " | 70 |
| The wooden | " | " ..... | 70 | " | 80 |

He found that 70 per cent. of the work of the world is done before the age of 45. Nearly all the great systems of theology, metaphysics, and philosophy are the result of work done between 20 and 50 years of age. And this law holds good in animals and plants as well. Horses live about 25 years, but they are at their best from 8 to 14. Dogs live 9 to 10 years, and are best for hunting purposes from 2 to 6 years. Children born of parents healthy in middle life (from 25 to 40 years) are stronger and smarter than those born of parents either younger or older than these extremes; and the same fact applies to the breeding of other animals, as in horses, dogs, and cattle. The hen has her best laying capacity at her third year. She will lay in an average lifetime, say 9 years, from 500 to 700 eggs. In her first year only 18 eggs; in her second year, about 110; in her third, 130, the golden period; her ninth year, only 10 eggs, if any. In old men the faculties morally deteriorate, as do the physical.

This does not necessarily make an old man a bad citizen in the true sense of the term, as of a neighbor or a harm-producing person. But unless sustained by a higher power, he is apt to give a looser rein to his feelings and expressions, to display irritability, less consideration for the feelings of others, and if he has had any variety of brain trouble, this is apt to reflect on his every act.

The diseases to which the brain is liable through a long course of years are many, such as blows, destroying the memory of names, dates, locations, and events; a bereavement has destroyed the memory of names alone. Millionaires once known for their liberality have grown stingy in old age. Hemorrhage in the brain and the various disorders within the cranial cavity have suddenly or more gradually made the clever foolish, the patient petulant, the hopeful despondent; have caused men and women too to change almost instantaneously their religious and their political doctrines. When the intellect is impaired by disease of any kind, or by the decay of age, men cannot distinguish the true path as of old, even when they desire to do so.

The changes in the brain from old age much resemble a diseased condition, either like the result of hemorrhage from the giving away of the cerebral arteries, from thrombosis, from hardening of the arterial coats, from meningitis, congestion, from anæmia of the brain substance, from nerve tissue decay, and from softening; and death in aged persons is more frequently a process than a sudden event, the process being one of very gradual, incapacitating decline of the mental faculties. An old man may begin to die ten or fifteen years before the absolute death of his body really occurs; and, like a tree, he may die beginning at the top and going down to the trunk. The decline in the moral faculties in old age may be shown in studying the lives of such men as Demosthenes, Cicero, Sylla, Charles V., Louis XIV., Frederick of Prussia, Napoleon, Voltaire. Dr. Samuel Johnson, Oliver Cromwell, Ruskin, Dean Swift Milton, Lord Bacon, Webster, and Horace Greeley. Old men decline in various faculties, some becoming peevish, others avaricious; some mean, filthy, and tyrannical; others quarrelsome, sensual, unjust, revengeful, and ungrateful for past favors and kindness.

The best average barometer of mental force is the memory, and decline or any deterioration in the power of the memory is the advance guard in old age, which sooner or later invalidates the forces of the brain. Most men show their mental powers in middle life, while their advanced years are the periods when they apply and reap the harvest of the work executed or planned in their palmy days. Thus Lord Bacon, Swift, Dickens, Ruskin, Thackeray, Carlyle, Emerson, Wendell Phillips, Graefe, Pinel, Luther, Nelson, Harvey, Webster, Jenner, Jefferson, and Washington did their best work before old age got the better of them. Sterne said that "At sixty years of age the tenement gets fast out of repair;" and Emerson says, in his "Plea for Old Age," "We cannot count our years until there is nothing else; to count," and added, "We postpone our literary work until we find that our literary talent was a youthful effervescence which we have now lost." Dr. Oliver Wendell Holmes says: "New ideas build their nests in young brains, and the whisperings of new truths are not caught by those who begin to feel the need of an ear trumpet."

General Halleck, in his work on "Military Science and Art," shows that mainly all the successful campaigns of history have been fought by comparatively young men, men in the prime of life, and that most of the early successes of Napoleon were gained over old and worn-out generals.

In the late civil war of the States, the North began with old generals, and failure was the result, and the average of the later generals who finished that contest was between thirty-five and thirty-nine years. We find the average age of the fifty-six signers of the Declaration of Independence was between forty and forty-five years of age.

Mr. Guernsey, of the New York bar, said: "From twenty-five to forty may be considered the seed time of life; that is, the time when knowledge is accumulated, and stored up for future use."

There are three causes of moral decline in advanced life:

1st. Is the overtasking and overexercise through adult life of the physical and the intellectual faculties, to say nothing of early sexual abuses.

2d. Diseases of the brain, or of other organs, which react on the brain.

3d. Intellectual decline, or the gradual process by which all living beings decay and die.

The question of legal responsibility comes up in old age:

1st. As to cases of crime by aged persons.

2d. Cases of wills, which are disputed on the ground of senile incapacity.

3d. When it is desired to fix the limit, as to term of office, etc.

4th. As to cases of priority of invention, etc.

Corruption in business and in political life and breaches of trust are common among the old, as every day's papers inform us. Offenses which depend upon sexual passion are not infrequent among the aged, for it is well known that in the decline of life many return to the vices of their youth. Even clergymen, old men, have been charged with such irregularities.

Cases of wills contested on the ground of senile incapacity are frequent enough, often giving rise to much trouble and estrangement among members of the same family; and an evident presumption would often lead to an incapacity to dispose of by will wisely the accumulated possessions of a lifetime.

A man in the decline of old age may be irresponsible more or less in one or more directions, while responsible in others. Few men break down all at once merely from decay of powers, but the faculties leave one by one, as the one first becomes defective, or softened if of the brain, while the others remain for a while longer fairly healthy, as an army in retreat moves off, some holding their position while other regiments fall back. Thus the wear and tear of aged persons may be rapid, save where money, the touchstone of life, is concerned, for the old man cares rather for the money *in ipso* than for the good that money can bring. Grudge or personal spite, unnatural enmity against a person, relative or not, often occurs in advanced age, amounting even to more than a disagreeable eccentricity, to almost a disease, and may influence judgment even against those who have been kind and affectionate toward the individual. It is difficult and generally fruitless to endeavor to remove this prejudice.

Then the aged are liable to be deceived by designing persons and have influences exerted over them which in their better day they would have seen through or have not tolerated. The case of Horace Greeley may be cited as an instance of the irresponsible condition of an old man, he becoming inordinately fond of money as soon as disease invaded his brain, and yet he became insane the last week of his life and his will was disallowed.

When an old man, previously benevolent and wealthy, becomes in dread of the poor house and begrudges the fuel for his family, the meat on his table, and the clothing for himself and his family, there is reason to suspect very serious cerebral disturbance, which might suffice to incapacitate him from making his will.

An instance may be cited of an aged clergyman, who all his life had been mean and penurious. In his golden decade, in his thirty-fifth year, he had been a minister of the gospel, a noted preacher. Between seventy and eighty he became worse and worse; becoming a genuine nuisance. He lost his memory and his manners; lost his wife; he then married again under the most absurd circumstances; was then divorced from the wife, and again married. He then went into gross excesses; lost his physical health, which up to that time had been excellent, and finally lost all his money through the treachery of this last wife, who in the end deserted him in his poverty and in his imbecile condition. This man had during all these years made will after will. His friends now took him in charge and treated him as a confirmed imbecile.

Dr. Brigham, of Massachusetts, says that in this country insanity and other forms of brain trouble are three times as prevalent as in England, and Dr. Winslow, a celebrated expert in insanity, says: "In the incipient stages of cerebral softening, as well as in organic disintegration of the delicate nerve vesicles observed in what is termed progressive, general and cerebral paralysis, ending either in apoplexy or in progressive paresis or in childishness. In such cases the patient often exhibits a debility of the mind, of body, and of memory more especially, long before the disease of the brain is suspected in regard to the most trifling affairs of his life. He forgets his appointments, or goes to keep them before the appointed time. He is forgetful of the names of his particular friends with whom he has lived in the closest intimacy; he becomes irritable, mislays his books, loses his papers; he sits down to write on some matter of business, and his attention being diverted for the moment, he forgets and leaves his letter unfinished."

The memory may be considered one of the most delicate tests of the presence of injury or of the progress of natural mental decay in the brain. The case is cited of an old man, who could never recollect the names of the inmates of his establishment, recalling only the initial letter of each one. He accordingly kept about him a list of their names so as to indicate them.

Old age, wear and tear, will, like pressure from a bone on the delicate substance composing the brain, produce more or less complete death of the sentient being for the time. One of the early indications of softening of the brain is seen in the paralysis of the muscles of the face, *i. e.*, the drawing down of the eyelid, and the distortion at the angle of the mouth from paralysis of the corresponding muscles of the other side.

In many instances these irregularities and extravagances are but the premonitory symptoms of softening of the brain, that terrible malady, incurable, and which gradually destroys, one by one, the powers of mind and body, and reduces the poor sufferer to a living death. Sensations as of cold, numbness, pain, and of increased warmth at times may all be felt in a perverted state; in some everything touched feels cold; others can bear only the lightest wraps in bed on the coldest nights of winter.

Professor Simpson, of Edinburgh, knew persons with incipient signs of general paresis to complain of their fingers feeling like sausages, cold and fleshy; and it is well known that on the approach of a paroxysm some have had such a feeling about the tips of the fingers as to lead to the habit of biting their nails, and this habit is known to exist in many inmates of insane asylums. The manners in such people are very variable, being different only in that the feeling of numbness and inertia persist and are on the increase all the time with them; while in the adult healthy individual, if this condition comes on at all, it forms a brief attack following generally a recognized cause, and then leaves the party almost, or as well, as before the attack.

It is the opinion of many eminent physicians that there has been a large increase of brain diseases during the present century, and that this increase has occurred in an accelerated ratio in proportion as the strain in commercial and public life of the people has increased, making the struggle for position, for wealth, and even for existence so much more difficult than formerly, when man's ambition was to live simply and to follow the golden rule, thus requiring increasing struggle for the luxuries of life, which finally culminates in cerebral excitement under which the delicately organized brain is forced to yield. Eccentricity is but a name often covering painful afflictions, and any prolonged exaggerated conditions of eccentricity may be said to constitute disease (page 89, "Work on the Border Land of Insanity," by Andrew Wynter, Esq., M.D., of London). Many mental eccentricities are but the forerunners of serious mental failure. The inability to grasp a stick, the continued numbness of the fingers, the loss of memory in small matters, are often indications of serious cerebral disturbance. Dr. Graves, of Dublin, a distinguished physician and writer, cites a case, who could never remember proper names; and Dr. Samuel Johnson, the great English scholar and writer, the author of the beautifully selected passages in Rasselas of the Happy Valley, would attempt in vain to repeat the Lord's prayer in English in his later days, and yet he could repeat every word of it in Latin.

Dr. Samuel Rogers, the poet, in his later years, showed peculiarities of memory, very like those of persons known to be suffering from disease of the brain; he even forgetting that he had been a poet. This is an uncommon form of loss of memory, for once a poet, a man thinks himself a poet forever. Throughout history, from the ancient fathers to our own times, we find like failures for the period of old age. We need

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only cite the famous John Randolph and that great jurist Samuel Tilden, of New York.

In the Bible we read of David and the follies of his old age; of Solomon and his foibles with the fair sex; of the valor to-day and the cowardice to-morrow of Elijah, in his flight from Mount Carmel; all in the extreme old age; of Moses, the law-giver, who organized the Mosaic code, finally disappearing and wandering in the mountains lost to memory and to history, so that with all his legal lore he had not the mother wit to keep his bearings, or to leave his final testamentary evidence for future generations.

It has been said in this trial that many cases might be cited in green old age, where great ability and wonderful acumen were maintained even to the day of death. Such cases when seen at all are like angels' visits, few and far between, and "they stand out like meteors in the midnight sky."

Now comes a review of the last great

> "Scene of all
> That attends this strange, eventful history,
> Is second childhood, and *mere* oblivion—
> Sans teeth, sans eyes, sans taste, sans everything."

And we may add to this doleful picture sans will, sans memory and sans care for those who loved him.

See the picture of this poor old man, shrunken; not in his locomotor power alone, but in mind, and failing in his powers of memory, without which the noblest work of the Creator becomes useless, helpless, motionless and reasonless on the tide of life; is at the mercy of the slightest breeze by friend or foe—whichever most caters to his present whims; or like the feather tossed by the stormy waves, it was something once, but wilted and weighted down by the moisture of the sea, it is but a creature of chance. This old man was lame, blind, halt, toothless and his "voice had fallen in tone from the mighty starboard watch ahoy!" to the childish, feeblest piping and whistling, like the tiny reed; or like the creaking door, in his strength, left to rust and droop until no longer with any to care for it, in the end it tilts and falls, carrying danger in its fall. On top of and above all these threescore years and ten, he suffered from the grippe, that prostrating, debilitating, life-destroying grippe, which takes its name from the French word "tongs" or "seizings." The French are very *au fait* in their use and application of the proper words. This disease is known to the Italians as "influenza;" to the people of the far South as the "dengue," or break-bone fever, and in England as the "epidemic bronchitis." It is fearful in youth, prostrating to adults and fatal in old age.

In connection with all this disability, lasting many months, this old man attempts to publish his will. Often then he says to his brother and to his elder sister: "Don't you worry; I have already provided for you." He thought he had made this provision, no doubt, but on the contrary he utterly forgot to mention them. Poor old man! His good intentions took the place of good actions, which he thought performed, until at last he had neither will nor memory, but existed like a plant—simply on the sap that was left and on the light of other days. This honorable jury must forgive him, for he knew not what he did, being irresponsible and living on the visions, the *ignis fatuus* of past recollections—merely a creature of habit and repetition.

Thus his constant effort in business was a mere matter of habit and but the shadow remaining of his former good intentions toward those who were justly entitled to his beneficence. He did not even recollect the amount of his income, nor did he provide for over one-third of it, and the little he did attempt to will he divided to those he had forsworn. His memory was but a fume, a mist, like the froth on the beer glass—now present like a bubble, and then gone to rise no more.—*Med. and Surg. Reporter.*

## THE OUVIRANDRA FENESTRALIS.

THIS magnificent aquatic plant is remarkable by the nature and aspect of its leaves, which recall a fine and elegant piece of lace. It inhabits the waters of Madagascar, where it was discovered for the first time by Dupetit-Thouars toward the end of the last century. It was the Rev. Mr. Williams Ellis who introduced it into Europe. The following is an extract from a letter that he wrote to Sir William Hooker on the subject:

The rarest and most interesting object that was worth my last visit to Madagascar is the beautiful aquatic plant called *Ouvirandra fenestralis.*

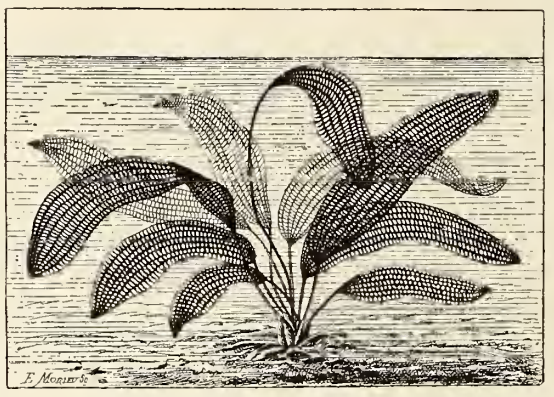
Dr. Lindley, among various plants to which he had called my attention before my departure from England, had particularly recommended this one to me in showing me a figure of it in Dupetit-Thouars' work. In the Isle of France, Mr. Boyer, a distinguished naturalist who once lived in Madagascar, pointed out to me liberally the localities in which I might stand a chance of meeting with the plant, and permitted me to make a copy of the plant already mentioned. This copy, made upon a larger scale than the original, was shown to the natives, and I finally succeeded in finding a man who was able to detect the natal place of the so much coveted plant. With the permission of his master, from whom I had received many acts of politeness, the man started out to look for the *Ouvirandra.* He returned two or three days afterward stating to me that he had met with it in a stream, but that he had been unable to secure it on account of the large number of crocodiles that the recent rains had caused to crowd to this point. Finally, he returned to the charge and brought me some samples in a very fair state, for which I was delighted to pay him liberally, and which I immediately took in charge.

The natives describe the plant as growing upon the margin of running water. The rhizome has a diameter of about 5 centimeters by from 18 to 27 in length. It is often branched in various directions like that of the ginger or curcuma, but is always in a single continuous piece instead of being formed of joints placed end to end. The plant is fixed to the margin of streams by numerous white and slender rootlets that penetrate the mud and clay and keep firmly fixed therein. It grows likewise in stations that become dry at certain periods of the year, and, under such circumstances, the leaves, it is said, are destroyed, but the rhizome preserves its complete vitality and puts forth new leaves as soon as the water moistens or covers the plant.

This plant is one of importance to the natives, who collect it at certain seasons of the year for food. Its rhizome, when boiled, furnishes a farinaceous substance analogous to that of the yam, whence its native name *Ouvirandra*, which means, literally, "water yam," *ouve*, in the Madecasse and Polynesian languages, signifying "yam," and *rano*, in the former dialect, "water."

The *Ouvirandra* is not only curious and rare, but also very beautiful in color and structure. From the various heads of the rhizome ascend, sometimes from a depth of 30 centimeters, a certain number of graceful leaves borne upon frail petioles, and that extend horizontally just under the surface of the water. The peduncle starts from the center of the leaves and terminates in two geminate spikes. But the leaf is especially eminently curious. One might call it a living fibrous skeleton, rather than a perfect leaf. The longitudinal fibers, extended in curved lines from the base to the apex of the limb, are united transversely by numerous filaments that form right angles with them, the whole exhibiting exactly the appearance of lace or a green embroidery. Each leaf exhibits itself at first as a short and delicate fiber, of a yellow or pale green color. Its sides soon develop, and its dimensions increase. At the various phases of their growth the leaves pass through innumerable shades of color, from pale yellow to dark olive green, and, later on, when they become destroyed, to dark brown, almost black. They attain a length of 30 centimeters and a width of 0·07 meter. I succeeded in carrying my plant to the Isle of France, where, for more than a year, I preserved it in full vigor. It seemed to prosper, especially in running water at a temperature of 74° Fah. I had the pleasure of offering specimens of it to Mr. Boyer, as well as to Mr. Duncan, the director of the Pamplemousses Botanical Garden. At the Cape of Good Hope, Mr. Gibbon had the kindness to take care of it during a five months' voyage that I made in the interior, and I left a specimen of it at the botanical garden of Cape Town. Upon returning to England, I had the great satisfaction of being able to offer this rarity to the Kew Gardens, and to those of Chiswick and Regent's Park.

The species under consideration is not the only one of the genus, for there is also the *Ouvirandra Heudeloti*, Kth., which inhabits Senegambia, and the *O. Bernieriana*, Dene, whose leaves are longer, narrower and more ribbony. These plants belong to the order Hydrocharidaceæ.—*La Nature.*



THE OUVIRANDRA FENESTRALIS OF MADAGASCAR.

## AMERICAN APPLE EXPORTS.

THE apple export trade from this country to England is by no means a new business, for as long as fifty years ago lots of a hundred barrels and upward were sent forward in sailing vessels that took from four to eight weeks to make the voyage. Ten years later slow steamships landed the fruit in from eighteen to twenty-five days, though not always in sound condition. Until 1870, 500 barrels of apples were considered a large shipment, but since 1875, with swifter steamers, the business has greatly increased, and is now a regular department of the fruit trade in which some fifteen firms in this city are engaged, besides half a dozen shipping brokers who see to arranging for space on the steamers and attend to other details of transportation.

In 1880–81, a season of good crops, the enormous quantity of 1,159,380 barrels went to Europe from United States ports alone. The carefully compiled reports of Mr. Mahlon Terhune, of this city, for the years since 1880, show great variation in the quantity of yearly shipments, the result of abundant or short crops. For example, in 1892–93, more than 650,000 barrels were shipped from New York, Boston and Portland; of these apples almost 250,000 barrels, or nearly thirty-eight per cent., were grown in Canada. The shipments made direct from the Canadian ports, Montreal and Halifax, amounted to nearly 546,000 barrels.

The apple export season dates from August to May, and from advance sheets of Mr. Terhune's statistics of shipments for 1893–94 it appears that the minimum quantity of less than 70,000 barrels went out from the United States this season, and but 86,000 barrels from Canadian ports.

These figures indicate, with the single exception of 1883–84, the dullest apple trade in twenty-five years. Reasons for this unusual export market are found in a short crop, made still smaller by the heavy storms of last autumn, large importations to England from other countries and the prevailing hard times. These exports, although comparatively small, were large enough to diminish appreciably the stock already insufficient for home use, so that prices have ruled unusually high in this market.

The first apples are shipped abroad about August 1, Keswick Codlins, from New Jersey, being the earliest export of last year. The Orange Pippin, a better fruit, follows closely, but the export of these tender summer apples is always attended with risks, and as they are needed at home, shipments are likely to continue small. During the year almost every variety of American apple is exported, and Fameuse and other delicate apples stand the journey well, Red Astrachan being one of the few kinds which rarely arrives on the other side in good condition. Redskinned apples are preferred in England by the masses, and the attractive King apple is in especial request early in the fall. But there are not enough of these, and in recent years Greenings, which come into market about the same time, have gained a place in spite of their inferior color. But the great export apple is the Newtown Pippin, the first American apple shipped to England. Coming originally from orchards in Newtown, Long Island, the best of these apples are now grown in the mountain districts of Virginia, where they are locally known as Albemarle Pippins. Here the fruit matures early and is ready for shipment by the 10th of November. These pippins, grown on Long Island and in the Hudson River district east of that river, mature later and are not fully ripened and well colored before January. On this side of the continent Newtown Pippins are grown only in the sections indicated. But the Northern orchards are dying out, and efforts at propagation are not successful, and the fate of the Spitzenberg twenty years ago threatens this fruit. Westchester County, formerly a great center for these apples, now produces small scaly fruit, and it seems to be only a matter of a few years when there will be none of these apples grown in the North. It has been thought by some that if the trees were not started from root-grafts, but were grafted high up on some vigorous seedlings, they might once more succeed where they are now failing.

In the Virginia district the fruit grows large and of excellent quality. In New York State three heavy storms last autumn cut prospective orchard harvests of fifteen hundred to two thousand barrels down to a few hundred barrels, but in Virginia the damage was slight and the crop was large and of the good quality which attends a full-bearing season. Quite as many Newtown Pippins went abroad, all Virginia fruit, as in other recent years, and at paying rates, prices in England ranging from 25 to 40 shillings a barrel for No. 1 fruit. They are largely used for table decoration there, and their rich flavor commends them highly, while they have also the crisp and sour qualities demanded in the English market. Their firm flesh and tough skin especially adapt them for packing and shipment, whereas many kinds, such as the Northern Spy, are easily bruised and discolored. The Newtown Pippin is much better known in England than it is here, since nearly the entire crop is exported. Christmas presents of these apples have long been fashionable, and banking firms in this city send abroad sometimes as many as fifty barrels to their business friends. More Newtown Pippins were offered in our markets this season than ever before, owing to the scarcity of other apples, but these were mostly second-rate fruit from this State and culls from Virginia, which in ordinary seasons would find no sale here. The stock of Newtown Pippins is always exhausted by March, and this year exports practically ended with the holiday trade.

Among the latest apples usually shipped are Northern Spies, which remain juicy and highly flavored to the end of the season and are sought after by the best trade. More Baldwins are usually shipped than of any other sort, and these are even later keepers. It has been said of Russets that they are an instance of the survival of the unfittest, but their merits are appreciated by a large number of buyers, and this apple ranks fourth or fifth in quantity exported. It is the longest keeper of all American apples, and is often shipped in April, while it has been sent to Glasgow and to English ports as late as June.

The firm prices which continued in England until February were then broken by large receipts from the Continent, and the demand for such American apples as were still held there was also affected by large receipts from Australia and Tasmania. The bulk of supply in England is, however, drawn from Canada, some of the best apples coming from Nova Scotia. These are of a quality superior to those grown in the United States and have remarkable keeping qualities. Transportation to England costs hardly more than freight into the United States, so that English markets stand the first chance with Canada shippers, especially as there is also a duty of eighty-four cents a barrel on apples brought from Canada into this country. So large a supply of Canada apples found their way to England last winter that prices were often $1 a barrel less than the same fruit brought here. The average wholesale price for apples in New York for the season of 1892–93 was $2.50 a barrel, and for the season just passed $4.50 a barrel.

Many of the apples exported come from Western New York; the largest apple farms have storage houses or cellars provided, and these are also found in many towns, for neighborhood use. At the beginning of winter the storage house or cellar is filled with cold air and closed up with the temperature at 28 or 30 degrees. Later in the season, when the temperature inside rises to 35 or 40 degrees, cold air is again let in. By this means apples are kept until the end of winter without ice. For late holdings cold storage is necessary. Shipments are usually made to commission dealers in the seaboard cities, by whom transportation is arranged for through a shipping broker. The fruit is sent on fast passenger steamships and is stowed in the hold away from the engine and boilers, generally in the forward part of the vessel, where the ventilation is best. In the early years of the trade apples were carefully wrapped in paper and packed in cork or mahogany sawdust, but no special precautions are now taken beyond having perfectly sound fruit. Shipments vary from 500 to 1,000 barrels, sometimes as many as 8,000 going on a single steamer. The fruit is consigned to an English agent, who remits the proceeds of sale after deduction for ocean freight, besides expenses for landing, harbor dues, delivery and sale. Cable advice as to prices is sent to the dealers on this side, and shipments made on such advice naturally result in gain or loss as the English market may happen to rise or fall. New York merchants tell of losing as much as $3 a barrel, while the highest authentic price ventured upon by a veteran dealer is 105 shillings a barrel for a half-dozen barrels twenty years ago.

The season here is nearly ended, and the few apples held in the interior of the State for trade values will all be disposed of before the new crop comes in from

the South. Roxbury Russets, Baldwins and Golden Russets are the only sorts quoted in the market reports. These now arrive at the rate of about 300 barrels a day and bring at wholesale $6, $5.50 and $5 a barrel. Dealers have recently divided their barrel stock into bushel lots, and these are offered in boxes at barrel rates.—*M. B. C., in Garden and Forest.*

## FAIR FORESTRY OUTSIDE OF THE UNITED STATES.

By JOS. CRAWFORD, Ph.G.*

OUR neighbors on the north were very kind, hence we will talk about them first, combined under the general term Canada, and contained in one inclosure.

They were the following, namely: Prince Edward's Island, Novia Scotia, New Brunswick, Quebec, Ontario, Northwestern Territory and British Columbia, with special mention of exhibits of Quebec, Northwestern Territory and Ontario.

These showed their vast timbers by sections of the trees, cross and longitudinal, plain and polished, as well as some very large sized boards, among them arbutus wood, which is not represented in the States.

Manitoba having such a good general collection, stood on her dignity and would not accept the small space allotted her, but erected a commodious building outside the fair grounds on Stony Island Avenue, opposite the California building, and there displayed her products to not only her satisfaction, but all visitors also.

A warmer neighbor, Mexico, presented to our view a very complete set of timber specimens, mostly of dark woods, but not well classified, and having lost our Spanish somewhere en route, we did not recover it until after sampling their genuine Zapote chewing gum, then these are what we saw and read: Under the South Colonnade, a mahogany log, 43 feet long by 41 inches square (Swietenia Mahogani), ebony (Diospyros ebeneum), bombax (Acacia Acapulcensis), mulatto wood (Xanthoxylon Clavi-Herculi), guaco (Aristolochia grandiflora), contrasting strongly to our small species of aristolochia, linoleum (Amyris lignalœ), cedar (Cedrela odorata), for cigar boxes, Brazil wood (Cæsalpina crista), Campeachy wood (Hæmatoxylon campeachiaum), dragon's blood (Pterocarpus Draco), many magnolias, Schinus molle, known as pepper tree, and which was used so much this past season as a decorative shrub on the fair grounds, especially around California building, cypress (Taxodium distichum), pitch pine (Pinus communis) and many forms of cactus wood. To represent their oaks, of which they have many species, they showed Quercus Virens or live oak, and claim it as the most durable as well as the strongest. The balsamo (Myroxylon Pareira) is one of their hardest, and used principally for railroad sills. Zopilote, an ash (Fraxinus trilobata) or Turkey buzzard tree, is a very common one; it has a smooth brownish bark, which annually peels off, depositing itself at the base of the trunk in large quantities and emits on fermentation the odor of musk. Mora excelsa, one of order Mimosæ, yields 75 per cent. tannin, according to their statement, and is found not only in the bark, but the wood itself. They call it Granadillo.

Spondia canescens furnishes a very hard wood, but as they say, its great peculiarity is to concrete its sap, in amber colored crystals as hard as flint, thereby completely inutilizing the implements of the workmen. Last that I shall mention from this country is the sweetest of all chictzapotl chicle (Sapota achras), which forms the most beautiful evergreen tree in the country.

Here we are now in Central America, but not in Forestry Hall, as they have their own buildings. Guatemala and Honduras in one and Costa Rica in another. The former did not lack material, but their method of exhibition was bad and also suffered much by neglect. The same could be said of Costa Rica's crude drugs, but her woods occupied conspicuous space on ground floor. They were arranged in two pyramids about 15 feet in diameter and same height, composed of tree sections and slabs, varying from 2 to 6 or 8 feet in length.

Among them we noticed zapotillo, laurel, quebracho, guayacan, roble, ten or fifteen varieties of cedro or cedar, cocobolo, sangre draco, palma, zapote, manzanillo and algarroba.

Venezuela's woods on exhibition were reduced to the number of 15 or 20, and no information was attached nor could any be obtained elsewhere.

In the Liberal Arts building was a fine display of the natural resources of Jamaica, and prominent among them was a large number of woods in slab form and condition; no attempts at classification, and nothing could be learned of them, to the great regret of those having them in charge.

Hayti had a very clever collection in her own building, arranged in the form of a large pyramid in a corner of the building and containing large specimens in natural and polished condition of these tree bearing official drugs or those closely allied to them: Xanthoxylon caribbean, Catalpa longisliqua, Bignonia arborea, Acacia arborea, Tecoma leucoxylon, Piper aduncum, Mimosa anjuscacti, Chiconea floribunda, Theobroma guozumi, Guaiacum officinale, Simaruba excelsa, Hæmatoxylon Campeachiaum.

Trinidad, or as their genial commissioner calls it, "The Land of the Humming Bird," showed fewer timbers but larger boards or slabs and finer colored woods than any other country. Also the only one exhibiting the purpleheart or amaranth, a species of copaifera. This resembled very much the heart wood of our red cedar, but durable in color and had very small portion of white duramen.

These woods were all board size, 1½ feet to 3 in diameter and 8 or 10 feet long, one half natural, the other polished, and besides the purpleheart were the galba, resembling cigar box cedar, locust, a dark red wood, guelpha, creamy white, very close grain, resembling a maple, tapana, reddish walnut color, and used for carriages, fustic, logwood, balata, roble, Guava pigeonwood, Spanish ash, and Copaifera officinalis.

British Guiana had a small collection of her timbers, and all highly polished.

Brazil's forests were represented by some 441 specimens from the state of Amazon, and among them please to note castanheira (Brazil nut) (Bertholetia excelsa), copaiba, cumara (Dipterix odorata), divi divi, cedro, audiroba, saboneta (Sapindus saponaria) and ucuhuba (Myristica sebifera). These are all useful timbers there, and few, if any, ever exported to this country.

Paraguay showed some 300 timbers, varying from 12 inches to 4 feet diameter, and most of them being polished slabs from which the bark had been removed and usually of that dark color so common to that country, Brazil and Argentine.

Argentine Republic succeeded finely as a country in showing her woods, as nearly every state responded favorably to the call, about 22 altogether, also 85 or 90 individual exhibitors.

The interest manifested was entirely too great for their allotted space, and about one-fourth only could be exhibited and remainder stowed away under platforms, tables, etc., and same inconveniences happened to their plants. They had 1,000 or 1,500 specimens of these and not space enough to place one in view. The timbers were of commercial slab size and mainly the dark varieties shown by private individuals, while the government showed the trees in lengths of 4 and 5 feet, with the bark remaining for one-third the length, while the remainder was half natural and half polished, so that the tree was presented in three conditions.

These principal ones were algarroba for walnut, mistol, roble, cedrela for cigar boxes, Palma nigra, black palm for ornamental posts, quebracho (Aspidiosperma Quebracho) resembles our white oak (Quercus alba) both in bark and wood.

Juglans Australis, their only walnut, approaches our black very much in color and grain.

Quebracho Colorado, another useful one, and also a great tannin producer, nearly 24 per cent., and also as a substitute for aspidiosperma.

Another wood resembling our walnut is the algarroba (Prosopis juliflora and nigra), and is actually exported as a substitute for it.

This belongs to order Leguminosæ, as does also Cæsalpinia melanacarpe, another walnut substitute.

Zapello (Pisonia zapello), laurel (Ocotea suaveolens), Quillaya Tellowiana and Eugenia pungeus are other important woods, making excellent durable timber.

They took great pride also in their tanning materials, and among the prominent barks and fruits for that purpose were these:

Acacia angice and abramontana, Psidium guava, Ocotea suaveolens, or laurel, Nectandra posphyne, root of mistol (Zizyphus Mistol), fruit Cæsalpinia Melanocarpa, barks of Juglans australis and Aspidiosperma, Croton succirubra, Berberis ruscifolia and Eugenia Michaela.

In striking contrast to their woods they showed the following, of which you may know something: Honey locust (Robinia Psuedacacia), alder (Alnus ferruginea), maple leaved negundo (Negundo Negundo). Many of our common beeches and the weeping willow (Salix Babylonica).

From Europe we had the excellent display of cork and cork tissue; from Spain also tans, dyes, licorice, collections of wood, including a very complete one from Philippine Islands. Mahogany from Cuba and Porto Rico.

France not only finely illustrated what they were doing to perpetuate forests by showing us their reports of directors and inspectors of forestry, which were very complete, but showed us many blocks of wood 8 × 12 inches and 22 inches thick with bark removed and surface polished, some dye materials and valuable knobs for veneers, some of which were valued as high as $1,000; also a good collection of seeds and cones. Adjoining France was Siam's exhibit, consisting of 20 or 30 pieces of wood, well polished, but not named. A handsome council table of teak wood attracted considerable attention. In spite of printed warning "Hands off," hands were "on" entirely too often. The names of vandals have a wider reputation this Columbian year than any previous one.

Some cordage also claimed our attention as composed of the long rattan. They find it much more durable than manila, even for cables. Edible birds' nests proved an attraction, if not a delicacy.

The series of rattan baskets were unique and very artistic; they were made entirely by convicts, but the prices were most surprising.

The Javanese had similar work and much cheaper.

Germany had no exhibition of woods, or so few as not to be noticeable, but showed these fine wood productions: Beer casks barrels, tubs and vats; also cork in its varieties.

The Forest Academy showed the scientific methods of forest culture as practiced in that country.

Sweden showed wood pulp industry and cellulose derived from spruce trees, but no attempt to represent timbers.

Russia's exhibit was characterized by crude and manufactured material from the linden bark fiber (Tilia Europea), and comprised nearly everything, from shoes for the sole of the foot to thatched house to abide in. Shoes, slippers, rough garments, kitchen utensils and other household articles, matting, brooms, brushes, planking, thatching and many others, which we could not stop to consider, but the whole line was very interesting to every one.

They had also many fine sections of timbers, but no cosmopolitan classification, and we could decipher very little information concerning them.

The administration of crown lands gave a finely illustrated idea of timber and its culture, diseases of trees, medicinal plants and roots, gums and resins and forest management, as also did the Forest Academy, of St. Petersburg, and the Russian Agriculture, Forestry and Mining Commission.

Japan conferred an honor upon us which, I fear, was little known, that of being the first country to receive a display of her woods outside of her own, or any attempt to represent them in a foreign land. I have reason to believe that Philadelphia museums will eventually receive the entire forestry collection, as their courtesy toward Philadelphia people was decidedly marked, and the least favor more than reciprocated, notably the secretary of the commission, Mr. Shikasa Suwa, who took almost a boyish delight in those people who did ask questions, and was untiring in his efforts to please them.

The space allotted was entirely too small, and hence crowded inside aud out, with scarcely space enough for an aisle.

There were two methods of showing woods, and in both cases were prepared timbers, bark having been removed. One style was a framed collection of the sections about 10 × 14 inches and about 20 or 25 to a frame, the other was by means of unpolished boards, 8 to 10 feet long, and the width of the tree.

Their attempts at labeling were very successful, and beside the technical name they had the common English name as well as the Japanese; also the general characters under which the tree existed and flourished, as well as its direct uses to man.

For their lacquer work the principal tree is the Paulownia (P. Imperialis), a tree which is adapting itself to our latitudes and proving a fine shade tree.

Another for the same purpose is zelkova kaki, one of the elm family, and still another is a horse chestnut (Æsculus turbinatus), called by them "Tochi."

Their largest trees are the cryptomerias, a class closely related to our Southern cypress, often reaching wondrous heights, and are the admiration of all visitors to that empire.

With that little relation of cryptomeria to cypress, we are able to find some of our genera represented by species close to our own. For that resemblance to relationship we feel very much at home among them. For instance, Taxus cuspidata, or yem, Thuya obtusa, or Arbor vitæ, Æsculus turbinatus, or horse chestnut, Tilia cordata, or linden, Morus alba, mulberry, Juglans Siboldii and regia, walnuts, Acer Japonicum and palmatum, maples, Fraxinus pubinervs, or ash, Magnolia hypolenca, or magnolia, Castanea vulgaris, chestnut, Alnusi firma, alder, Betula alnifolia, birch, Quercus acuta, gilva and glauca, as oaks, Diospyros Kaki, persimmon, Pinus densiflora, pine, Rhus succedaneum and vermicifera, near relative of our Rhus tox.

Paulownia we have established in this country, as also another Japanese, the gingko (Salisburia adiantifolia).

There are also three other trees which were represented by sections at the fair—Cedrela chinensis, Torreya nucifera and Cinnamomum camphora.

The department of agriculture and commerce had an exhibition of maps, plans and illustrations of forest growth, woods, plants, wax, resins and wood pulp for paper, bamboo cane and baskets, tanning material, etc. They also had as here represented in the group of the world in the center of Forestry Hall two bamboos, each over 70 feet long.

India's exhibit consisted of many fine pieces of carved wood, usually teak, timber in the rough, as well as fashioned to show to best advantage, specimen tans and dyes, oil-bearing substances, gums, resins and fibers.

We will limit this description to timbers, namely, those yielding drugs of our acquaintance and to the carvings.

The great mantel piece was compound of Shisham wood (Dalberjia sisso), redwood, walnut, boxwood, and some fragments of very old teak and blackwood, found in some ruins near Madras and dock excavations in Bombay.

The teak is about 600 years old and the blackwood dates possibly from before the Christian era.

The carved doorway of teakwood shown there is of the same design and general outline of those used in the thrones of different parts of the Mandalay palace, but the detail is more elaborate than anything the palace contains.

The triangular space above the door contains designs intended to represent the city of Mandalay, with the king and his courtiers.

The lowest tier shows the city wall, with one of the seven-roofed gateways; on and around this are the guardian "nats" of the city and other mythological figures.

The second tier is supposed to represent the king's ministers, and the highest represents the king and his queens in the palace.

It is executed by a Mandalay carver, under direction of Conservator of Forests, Upper Burma.

Among the timbers were the following arranged in well seasoned slabs, bark removed from most of them, and in various sizes and shapes—acacia, arabica, leucophloea, sundra, and catechu.

Acrocarpus fraxinifolius, used chiefly for tea boxes and shingles.

Ailanthus excelsa, a soft wood like the Ailanthus glandulosa common here. This is used by them for sword handles, spear sheaths, and catamarans.

For these boats, however, they use a better wood, Gynocarpus Jacquain, so light that its weight is but 20 lb. to the cubic foot.

In heavy contrast to this, however, is the Hardwickia binata, which is one of their ornamental timbers, and weighs 82 lb. to the cubic foot.

Wabo (Bamboo gigantea) is, as its specific name implies, a gigantic species of bamboo frequently reaching 125 ft. and 25 to 30 in. in circumference, and those on exhibition were 64 ft. long.

It is chiefly used in light work, scaffoldings, etc.

Bombax malabaricum is a curious wood which is white when cut, but turns dark on exposure, and strange to say is durable only under water.

Anacardium occidentale, another member of our cashew nut family, produces a wood moderately hard, used for packing cases, boat building, and charcoal.

Cassia fistula, very durable, but not strong enough for timber.

Satinwood, our hair brush acquaintance (Chloroxylon Smietenia), used for everything from agricultural implements to toilet articles.

Cedar (Cedrela Toma) is special adapted to carving and furniture, as it is not susceptible to attacks of white ants.

Ebony (Diospyros ebeneum) for inlaying, making marked contrast, also valuable for furniture otherwise.

Shisham (Dalbergia sisso) is a valuable tree for carving, also the species latifolia, as well as Melia Azrederach.

This is held very sacred by the Hindoos and their idols are made from it.

Cinnamomum glanduliferum for boat building, etc. Pterocarpus marsupium and Santalinum Strychnos Nux Vomica, and potatorum, all are useful, and teak (Tectonia grandis) is one of their best, for when it is well seasoned it does not crack, warp, or split, and is not injured by white ants.

Erythroxylon monogynum, used as a substitute for

* From the *America Journal of Pharmacy.*

sandalwood (Santal album), which is highly prized for carvings and incense as well as for perfume.

Tamarindus indicus furnishes a rich dark red wood.

Padouk (Pterocarpus indicus) is their most valuable tree for construction of furniture, and the Inspector General of Forests predicts a better future for this than teak or mahogany every had.

Ceylon had no collection of woods in Forestry Hall, but in their court in Agricultural building there was quite a fine display which proved uninteresting until the purchase of a Hand Book of Ceylon Courts, that proved itself the most valuable of its kind, as it treated briefly and pleasantly of the natural history of the island, botany, ethnology, language, religion, fibers, etc., agricultural and tea cultivation, besides being valuable for locating the different portions of these exhibits and for describing the different articles on exhibition.

The woods with somewhat familiar names were: Eugenia bracteata, Cassia fistula and siamea, Melia dubia, Diospyros ebenum and five other species, Mallotus alba, Erythroxylon monogyrum, Pterocarpus marsupium, Strychnos Nux Vomica, Tamarindus Indica, Myristica laurifolia, Tectonia grandis, Albizzia odoratissima. Suringa-mara, one of their hard woods, is used to make pestles and mortars. Singhalese kind, however. Satinwood (Chloroxylon Swietenia) is as abundant and useful here as in India. Another valuable one is the "Nandoon" (Pericopsis mooniana), found only in Ceylon.

The tamarind produces a variegated wood, very ornamental, and but little inferior to calamander, which is a persimmon (Diospyros gueesita), the most attractive cabinet wood in Ceylon.

In this hand book a chapter is devoted to native medicinal plants and medicines, and I found it so interesting that I beg to quote a paragraph for the sake of Ceylonese polypharmacy.

"In most cases the treatment only serves to change an acute disease into one of chronic character, while recovery from a single affection is protracted, the patient being kept half starved on gruel and made to swallow huge quantities of infusions and decoctions of medicinal herbs, villainously compounded, the number of ingredients in each portion increasing in direct ratio with the continuance and severity of the malady."

A mild form of fever, for instance, would be treated with a decoction of the five minor roots—Desmodium gangaticum, Uraria lagopodioides, Solanum Jacquini, Solanum Indicum and Tribulus terrestris—which are believed to cure fever due to deranged phlegm, catarrh, etc.

A severer form would be ascribed perhaps to deranged air, requiring the use of the five major plants—Ægle marmelos, Calosanthes Indica, Gmelina arborea, Stereospermum suaveolens and Premna speciosa.

In remittent fever, etc., all ten may be prescribed together, and in typhoid fever, with head symptoms, all these with eight or ten others.

Many articles of their pharmacopœia were on exhibition, some not unknown to ours. The display of cinchona barks and cinnamons was very fine.

The exhibit of New South Wales was the only one in forestry from Australia, and a glance at it showed the excellent judgment of the commission in selecting those timbers which are most useful in their industrial arts, for their original intention was to show some 19 classes relating to forests and prepared woods, but there were but 6 on exhibition.

Two of the small ones will be considered now and the third later on.

Under class of dyes and tans, there were 3 large collections, and strange to say all the tans were genus Acacia, two (2) of wattle bark (Acacia decurrens) and one (1) of hickory (Acacia penninervis).

The wattle of Raymond & Co. analyzed 35·75 per cent. tannin and 39·5 per cent. extract.

The space allotted Australia was neatly inclosed by a sort of stockade effect in planks, nine (9) feet high and two (2) to three (3) feet wide, polished to half their length or more and labeled in vernacular. The classes of logs, worked timber, and ornamental woods will be considered together, as the best work of the Director General of Forestry was with these three (3) classes.

They consisted of various sized specimens sufficient to show best characters of them from the boards forming the outer wall of the exhibit, to herbarium size of wood and bark, 12 × 18 in. Chief of the large timbers were the mangrove (Avicennia officinalis), swamp oak (Casuarina glauca), forest oak (Casuarina torulosa), red cedar (Cedrela australis), rosewood (Dysoxylon Fraserianum), and 9 species of Eucalyptus, E. botryoides, bastard mahogany; E. crebra, gray iron bark; E. longifolia, woolly butt; E. macrorrhyncha, stringy bark; E. microcorys, tallow-wood; E. pilularis, black butt; E. paniculata; she or pale iron bark; E. poprulifolia, red box; and E. resinifera, forest mahogany.

Also these indigenous trees, nine (9) species of Acacia of which decurvens is the most valuable for tanning purposes, as it yields from 25 to 35 per cent. tannin and is known there as green wattle.

Acacia penuerius, known as hickory, and Acacia salicina as native willow, apple tree, Angophora intermedia, black oak as Casuarina suberosa, sycamore, Cryptocorya obovata, sassafras, Doryphora sassafras, white tea tree, Melaleuca leucadendron, and 18 species Eucalyptus.

Of the herbarium sizes there were 105, showing bark on one side and wood on the other, and included 17 species Acacia, 5 Casuarina or so-called oaks, 19 Eucalyptus, 6 Melaleuca and the remainder in genera not specially interesting.

Eighty (80) species, showing seeds and seed vessels from the following and others; 10 Acacias, 5 Casuarinas and 26 Eucalyptus; 107 barks, principally Acacias and Eucalyptus; 27 of the latter were noted and 5 of former, Mallotus philippinensis, Duboisia myoporoides, etc. These were about 12×18 in., and banded by a thin strip of metal, and suspended, when they formed a most pleasing part of this exhibition, and the 27 Eucalyptus were the most interesting of the section. For outside the interest with which we consider them in materia medica, they are a wonderful class to all who stop long enough to compare one species with another, as, for instance, the great variation in the bark is of itself startling; there are all gradations from the smoothest to the roughest and most deeply fissured we have in any tree, all to be found in this one genus Eucalyptus, and as strange as the barks were startling are some of the vernacular names applied to these trees.

Besides those mentioned previously are such as these: Yellow box, swamp mahogany, blue gum, spotted gum, white box, blood wood and peppermint; consequently they specify this as pipetta.

The commission showed also in another class photographs of their typical trees.

Woolly butt (Eucalyptus longifolia), 230 feet high and 33 feet circumference.

Black butt (Eucalyptus pilularis), 280 feet high and 59 feet circumference.

Spotted gum (Eucalyptus maculata), 300 feet high and 18 in circumference.

Native fig (Ficus macrophylla), 250 feet high and 36 feet circumference.

River oak (Casuarina glauca), 120 feet high and 16 in circumference.

Turpentine (Syncarpia laurifolia), 200 feet high and 30 feet circumference.

In conclusion I might say that there are about 50 species of Eucalyptus in Australia, and all useful in some way or other, but chiefly in those cases when strength and durability are desired. They resist both fire and water, therefore very little in demand for fuel.

These also rank as the highest trees of the world, as the species Amygdalina was found with a diameter of 81 feet and a height of 480 feet, and according to some authorities this is 150 feet higher than the Sequoias of California.

So at this nearly antipodal pinnacle or tree top, I will leave you to draw your own conclusions, whether or not this World's Columbian Exposition was the most colossal of its kind, and its forestry feature a pronounced success.

[Continued from SUPPLEMENT, No. 960, page 15342.]

## EXTINCT MONSTERS.*

A BRIEF ACCOUNT OF SOME OF THE MOST REMARKABLE FORMS OF ANIMAL LIFE IN THE PAST HISTORY OF THE EARTH.

By STEPHEN BOWERS, A.M., Ph.D., editor of the *Fallbrook Observer*, Fellow of the Geological Society of America, Corresponding Member of the Geographic Society, Philadelphia Academy of Sciences, Member of the Philosophical Society of Great Britain, etc.

### FLYING DRAGONS.

IT was a long time before learned men would admit that a flying dragon was possible. But the research of the geologist has brought their remains to light, and they are as well known to-day as the Dinosaurs or the Mammoth. They navigated the air in the long past, and were contemporary with the Ichthyosaurs, Plesiosaurs and Dinosaurs, whose characteristics we have already described, as well as many other reptiles. They are known as Ornithosauria, or bird lizards, because they are partly saurian and partly bird-like.

Among these extinct flying lizards are Pterodactyls, a name derived from the Greek *pteron*, wing, and *dactylos*, finger; hence they are called "wing-fingered" creatures. They had the power of flight, "not by a membrane stretched over elongated fingers, as in the bat, nor by a wing without distinct and complete fingers, as in the bird, but by a membrane extending from the arm to the tail, supported chiefly by a greatly extended little finger, the other fingers being short and armed with claws." The remains of many flying dragons have been found, varying from that of a sparrow to monsters whose spread of wing probably exceeded twenty-five feet.

These singular reptiles could, most likely, perch on trees or hang on the side of perpendicular cliffs, or stand on the ground or swim in the water. They probably walked on all fours, as some Dinosaurs, or on their hind feet at will, or they could dive into the water in quest of fish. Indeed, they possessed the characters in part of reptiles, mammals, and birds, and it is difficult to determine which predominated. They had four fingers, and were furnished with claws, while birds have but three fingers in hand or wing. All mammals have a skull joined to the backbone by two articulations, while Pterodactyls have but one, as in birds and reptiles. Their jaws show that they were constructed on the reptilian plan and not mammalian. They had powerful muscles in the region of the chest to enable them to fly. They doubtless had lungs like birds, and their bones were supplied with air by an elaborate system of air cells; but this does not argue relationship with birds. They were probably warm blooded.

Many of these strange creatures had enormous teeth, conical and the points turned backward. The large forms found by Professor Marsh in the Rocky Mountain region, however, were without teeth, but their enormous beaks were horn-like. One can imagine that a monster "bird" (if such it could be called) with a spread of wing of twenty-five feet, large head and neck, and beak of horn, two or more feet long, would be a formidable antagonist in combat with other forms of life. The Pterodactyl had large eyes, giving it powerful vision. It had a long tail, and, when flying, must have resembled a boy's kite. Its neck must have assumed the shape of the letter S in order to support the large head and give equipoise to the body generally. It had no feathers, but probably folded its leathery wings when at rest.

"Half-vampire, half-woodcock, with crocodile's teeth along its tapering bill, and scale armor over its body, it was qualified," says Dr. Buckland, "like Milton's fiend, for all elements, the creature was a fit companion for the kindred reptiles that swarmed in the seas or crowded on the shores of a turbulent planet:

"The fiend
O'er bog, or steep, through strait, rough, dense or rare,
With head, hands, wings, or feet, pursues his way,
And sinks, or swims, or wades, or creeps, or flies.

"With flocks of such like creatures flying in the air, and shoals of Ichthyosauri and Plesiosauri swarming in the ocean, and gigantic crocodiles and tortoises crawling on the shore of primeval seas, lakes and rivers, air, land, and sea must have been strangely tenanted in these infant days of our land."

* From the author's pamphlet.

These lizards or flying dragons began their existence in what is known as the Jurassic period, culminating toward its close, and extending to the termination of the succeeding period, the Cretaceous, when they suddenly disappeared. Many geologists have been greatly puzzled at the sudden disappearance of forms of life at various stages in the geological history of the earth. But the Vailian or Annular theory clearly explains this in the fall of the rings of overcanopying vapor containing much of the solid matter now composing the crust of the earth. It swept them from the slowly forming world, giving place to other forms of life which succeeded them. It must be remembered that the geologic history of our earth can scarcely be counted by years. Every leaf in the great Stone Book declares that time is long. In our next we will have something to say of the old sea serpents of the past.

### SEA SERPENTS.

The great Stone Book furnishes the remains of marine reptiles which propelled themselves by means of their tails and elongated bodies. They also had fins, and while, strictly speaking, they were not serpents, but saurians, nevertheless the name serpent has been accepted by geologists, and we use it in that connection in this chapter.

The remains of one of these monsters was found embedded in the rocks in Europe more than one hundred years ago. In blasting a tunnel in the mountains near Maestricht, a city in the interior of the Netherlands, the huge jaw of a sea serpent was laid bare. It was about four and one-half feet long and two feet wide, with numerous teeth, some three inches long. The backbone consisted of one hundred and thirty-one vertebræ, of which ninety-seven belonged to the tail, the total length of the skeleton being about twenty-four feet. It was named Mosasaurus, from the river Meuse. Later discoveries show it to have been a marine reptile of great strength and activity, having a large tail flattened vertically and capable of being moved from side to side with rapidity, making it a powerful organ of propulsion. But the largest forms of this great saurian have been found in America. In the great inland Cretaceous sea which once covered the spot now occupied by the Rocky Mountains they lived in prodigious numbers. In that ancient sea they seemed to have reigned supreme. They were carnivorous in their habits, and attained a length of seventy-five or eighty feet. The museum of Yale College has a collection of more than fourteen hundred skeletons of these great sea lizards. More than fifty species have been discovered in this country. They had large, flat heads, conical in shape, with eyes directed partly upward. They had two pairs of paddles or flippers, and, like snakes, were furnished with four rows of formidable teeth, conical and recurved. Each half of the lower jaw was articulated, as in true serpents, permitting them to swallow their prey whole.

The reader must bear in mind that Mosasaurus was a long, slender reptile with powerful paddles in front. The tail was long, flat, and deep, like that of eels. A genus known as Clidastes, found in Kansas, is noted for its slender body, reaching a length of forty feet. Some of these sea reptiles had sclerotic plates in their eyes, forming an optical instrument of varied power, that, like the Ichthyosaurus, could use it as a telescope to see in the distance, or as a microscope to see an object near by. One species had a long projecting muzzle similar to the snout of a sturgeon.

Other marine reptiles lived at the same time, but with thicker bodies, called Elasmosaurs. This group is not yet fully worked out, but sufficient is known to believe that they were monsters indeed, some attaining a length of one hundred feet. They strongly resemble Plesiosaurs, which we have already described. They seem to have been able to live on the land as well as in the sea. They had very large teeth with strongly marked ridges. Professor Cope describes the monster in the following graphic style: "Far out on the expanse of this ancient sea might have been seen a huge snake-like form, which rose above the surface and stood erect, or swayed about, describing a circle of twenty feet radius above the water. Then, plunging into the depths, naught would be visible but the foam caused by the disappearing mass of life. Should several have appeared together, we can easily imagine tall, flexible forms rising to the height of the masts of a fishing fleet, or like snakes twisting and knotting themselves together. This extraordinary neck—for such it was—rose from a body of elephantine proportions. The limbs were probably two pairs of paddles, like those of Plesiosaurus, from which this diver chiefly differed in arrangement of the bones of the breast. In the best known species twenty-two feet represent the neck in a total length of fifty feet. This is Elasmosaurus-platyrus, a carnivorous sea reptile, no doubt adapted for deeper waters than many of the others. Like the snake bird of Florida, it probably often swam many feet below the surface, raising the head to the distant air for breath, then withdrawing it, and exploring the depths forty feet below, without altering the position of its body. From the location in which the bones have been found in Kansas, it must have wandered far from land; and that many kinds of fishes formed its food is shown by the teeth and scales found in the position of the stomach."

### SOME NEW WORLD MONSTERS.

Far back in Eocene times a great inland sea occupied much of what is now known as the State of Washington. Its shores and islands were covered with a tropical vegetation, among which roamed innumerable animals. Some of these forms were as curious as the imagination can well conceive. One of the most singular has been named by Prof. Marsh Dinocerata or terrible horned monster. In appearance it resembled the rhinoceros, the elephant and the hippopotamus. From the skull rose six bony protuberances which probably supported three pairs of horns. The two canine teeth of the upper jaw developed into long dagger-shaped tusks. The limbs were strong and massive and the head large, but the brain exceedingly small. The body of a full-grown form was about twelve feet long and weighed fully six thousand pounds. From the position in which these remains were found, it is believed they roamed through the tropical forests in vast herds. It was abundant for a long time, or until the close of the Eocene period, when it suddenly disappeared.

Into the old Eocene sea, of which we have spoken,

flowed numerous rivers which continually brought down sediment from surrounding elevations which gradually filled it to the depth of more than five thousand feet, in which repose the fossil remains not only of Dinocerata, but numerous other forms of life. As this inland sea gradually filled with sediment other streams led out, cutting deep gorges until it was drained completely dry, and there was no more sea in that region.

In the Eocene beds referred to, Marsh found the earliest representatives of the horse family. Eohippus, which means dawn horse, and Orohippus, mountain horse, were found here. They were about as large as a fox. In front they had five toes and three on the hind foot. The two bones of the leg now united were then separated. In the lower Miocene the Mesohippus made its appearance with a small, but useless, fourth toe, and the leg bones united.

Next comes the Protohippus, an animal larger, and more like the present horse. In this the fourth toe has disappeared and the two side ones are short and useless. The Pliocene period developed Pliohippus with a single full toe, and small remains of the two outer ones, while the Quaternary period gave us the modern horse, with the fully rounded and single-toed hoof, the side toes being reduced to simple splint bones. The remains of this horse have been found at the head of Oak Street, Ventura, and different portions of Ventura County.

More than forty species of the fossil horse have been discovered, and while it cannot be properly classed as a "monster," yet the Pliocene and Quaternary periods yielded much larger species than now exist on the earth. The horse seems to have disappeared from this continent before the advent of man, and those he introduced are believed to have come from Asia or Africa.

In the country east of the Rocky Mountains the remains of another strange group of quadrupeds have been found. One of these which Prof. Marsh names Brontops lived after Dinocerata had passed away. They were probably larger than the former animals, and flourished in Miocene times. Brontops resembled the rhinoceros in some respects, but was larger. On its nose it supported a pair of stout horns. Its skull was long and large, measuring in a full grown form three or more feet, and the ends of the horns were nearly two feet apart. The fore feet had four toes and the hind feet three. It seems to have had an elongated and flexible nose like that of the tapir and the body was covered with hair or bristles.

When Dinoceras was living in such great abundance in tropical Wyoming, the jungles swarmed with other forms of life. Large rodents with heads a foot and a half long, the early horse, monkeys, foxes, wolves, a cat nearly as large as the modern lion, rhinoceros, camels, stags, and serpents existed and the waters were filled with fishes—some of strange forms—reptiles, etc.

### SOME OLD WORLD MONSTERS.

India furnishes some as strange forms of ancient life as any other country except America. At an early period in the Tertiary era it was a large island, but subsequent upheavals formed it into a continent. The uplift was probably gradual, as was that of the Sivalik Hills, which stretch along the southwest part of the Himalayas. In the strata composing those hills are found the remains of quadrupeds, birds, fishes, mollusks, and crustaceans. Elephants and mastodons once lived here in vast numbers, several species of rhinoceros, hippopotamus, horse, camel, ox, stag, antelope, and other animals.

But one of the most singular animals known to paleontologists is the Sivatherium, and which has never been found elsewhere, we believe. It was a large stag with four horns, and is supposed to have had the bulk of the elephant, but a greater height. It belonged to the deer tribe, and was probably the most gigantic specimen that has ever existed. The fore horns were short, but the two horns behind those were expanded, and were doubtless formidable weapons of defense. The Sivatherium gives us "a new type which seems to connect together two families, at the present time well worked off from each other, namely, the giraffe and the antelope." Its teeth resembled those of the giraffe, but its horns resembled certain antelopes. Its head resembled that of the ox in certain particulars, but was much larger. The upper lip terminated in a short proboscis, as that of tapirs. Altogether it must have been a strange-looking creature.

Another noticeable form from the same beds is that of a giant turtle. This monster when living must have been twenty feet long, with a shell or carapace twelve feet in length, and was probably higher than a tall man. A single arm bone measured nearly two and a half feet. It is believed to have had a foot as large as that of a rhinoceros. It lived in an age of giant mammals and reptiles. The Sivalik forms included not only the great variety of animals that we have named, but also crocodiles, lizards, and snakes. It is estimated that at the time when this great turtle and Sivatherium existed in India there were five times as many animals and reptiles as are now found living there.

### SOUTH AMERICAN MONSTERS.

South as well as North America has yielded some grotesque forms of life in the past. One of these, named by Cuvier Megatherium, from the Greek *megas*, great, and *therion*, beast—great beast—was allied to the sloths, ant eaters, and armadillos. It was nearly twice as large as the rhinoceros. One skeleton obtained in Pampas strata measured eighteen feet. The limbs exceedingly massive, the femur being three times as thick as that of the elephant. In circumference it was equal to the entire length. The tibia and fibula were united and cemented together. The tail was very large, and when this massive edentate stood on its haunches it formed a tripod similar to some of the Dinosaurs. The hands terminating the arms were a yard long, and were armed with powerful claws. The teeth, which were ten in number in the upper jaw and eight in the lower, and eight or nine inches long, had a grinding surface of triangular ridges. They had the peculiarity of continual growth from new material from beneath, which caused them to last as long as the animal lived.

Another peculiarity was that they were hollow prismatic cylinders. The snout and lips were elongated into a slight proboscis, and the animal had a long and powerful tongue with which it could strip the small branches of trees. Its skeleton indicates an animal of prodigious strength. Its arms were very long and it was doubtless capable of breaking down large trees, from the foliage of which it fed. Dr. Buckland says its entire frame was an apparatus of colossal mechanism adapted exactly to the work it had to do.

Another form of extinct sloth is the Mylodon. It was ten or twelve feet in length, and much larger than the buffalo. Still another form is known as Scelidotherium, which was as large as the polar bear. Its remains are found in great abundance in the vast estuary deposits which form the Pampas. It inhabited South America during the Pliocene period. It, however, is not confined to South America, but its remains have been found both east and west of the Mississippi River and on the Pacific slope. The renowned footprints found near Carson in sandstone strata, and first believed to be human, were doubtless made by a giant sloth. Indeed, the remains of the animal have been found in the same strata.

The Glyptodon, another South American form, was a gigantic armadillo. It was covered with a carapace or cuirass of plated armor that extended over the head and along the tail. The vertebræ of the backbone were fused together, forming a hollow tube, and joined to the under surface of its great shield to which the ribs were united. The total length of this singular animal was nine or ten feet.

*(To be continued.)*

## AVIAN ATHLETICS.

By MAURICE THOMPSON.

THE study of athletics, just now so popular, may be my excuse, if I need one, for spying upon my friends the birds, and reporting their gymnastics. One of the three things, yea, four, that passed the understanding of the old writer in the Bible was the "way of an eagle in the air;" and to this day, how a buzzard sails has not been satisfactorily explained.

Last November my attention was called to a flock of hawks (I do not pretend that the phrase is technically good) going southward high in air, moving by circular flight, each horizontal ring of advance forming a link in an imaginary chain which was to connect our frost-sprinkled climate with the warm, dreamy spaces of the South. Looking through a strong binocular glass, I followed the birds therewith till they passed beyond the horizon; and not a wing did I see make a stroke, save at long intervals an oar-like dip, as if merely to relieve the tiresome strain on the muscles.

Round and round they sailed, more than a hundred of them, a great giddy wheel rolling flat against the sky and gradually sinking from zenith to horizon, shrinking, shrinking, until, at the point of disappearing, they glittered like a silvery whiff of chaff just above the hills far southward.

I call that an incomparable display of aerial athletics. From how far north they came or to what southern point they went I do not pretend to know; it is enough that as far as I could see them they went on and on, apparently without effort.

There was a description in a newspaper the other day of how a hawk caught a carrier pigeon. The writer said that so long as the pigeon flew in a straight line it gained and drew away from its pursuer: but as soon as it began to zigzag the hawk overtook it. This brought to my mind what I once saw in the woods. A blue-tailed hawk was pursuing a turtledove; the flight seemed as swift as that of an arrow, although it was through a close growth of maples and beeches. Over and under boughs and around the boles of trees the birds whisked, apparently reckless of direction, and yet neither ever touched even a twig. How could eyes see and wings evade the multitude of obstacles behind obstacles? At last, when the hawk was within two feet of its victim, the latter dashed headlong into a flicker's hole in the body of a dead beech. Now think of it: that hawk was going faster than ever express train went, and yet it applied brakes and stopped short before reaching the tree! Speak of readiness, dream of what instantaneous response to exigency is, and then think of that movement; it was quicker than the burning of powder.

I have often wondered at the ease with which a great hen hawk drops from on high, like a falling shot, hitting so accurately its quarry on the ground; for at the moment of beginning its descent it closes its wings almost tight against its sides and goes as true as a plumb line. Before it reaches the ground its speed becomes so rapid that you hear the air fairly shriek through its feathers, and the heavy thud of the blow at the last is of deadly suggestion. I have seen a full-grown hare snatched up into the air limp and dead after such a performance and borne away dangling in a grip of fate.

An expert trapeze man does many wonderful things: but his extremest cleverness cannot equal that of a hawk which I saw dart under a flying kingfisher, turn back downward, and catch the bird in the breast.

Hawks, however, are not more expert than kingfishers themselves. The belted halcyon makes an unerring missile of himself when he sees a minnow shining in a pool of the brook, and from fifty feet distance goes, like a blue flash, to the silvery point. Chuck! Up leap a thousand shining drops and fall around like rain, while that animated and winged fish-spear comes forth from its plunge with the minnow safely held. Well may Halcyon giggle a raucous, clattering strain of joy; he has done what no man of us can learn to do.

The drowsy-looking little pewee flycatcher of our woods does almost impossible feats of agility in taking on the wing some species of dancing insects. I have seen one of these birds turn three or four complete somersaults in the air before finally he caught his gnat, which, like Galatea in the idyl, skipped hither and yon and up and down, after the manner of a harl of dry thistle down—ὡς ἀπ' ἀκανθας ταὶ καπυραὶ χαῖται—but there I go again; and a critic (of a sort) recently warned me that if I kept on with Greek I should soon be no better than Matthew Arnold and John Milton! As I was about to say, however, a kinsman of the pewee, the tyrant flycatcher, shows how a light and plucky tilter in the fields of air can outdo his most savage foe, by dint of superior cleverness at lofty tumbling. Many a time have I seen him bobbing up and down above a worried and disheveled hawk so high in the air that he looked like a bee harassing the wide-winged thing, mounting and hurrying through the hyacinth spaces of a summer sky.

Our black-capped titmouse is inimitable as a trapeze performer when he gets good hold of a twig's end. He can swing head downward, sidewise, curved till beak and tail touch; swing by one foot, and the wind may blow as hard as it can, he never loses his grip. No wonder Emerson loved him for his pluck and nerve. Some years ago it created a stir in old London when an athlete climbed to a temple's arch and hung head downward from a beam; but what is a feat like that when compared with what you may see any June morning when a titmouse hangs by one claw to the topmost leaf of some tall forest tree, and the wind blowing boisterously.

Have you ever seen two cock bluejays fighting in midair? There is a joust of brilliance! They whirl over and over so fast that they look like a blur of amethyst smoke, shot with gleams of white fire, and how their wings clash and their bills clack! Not much harm is done; but I venture to guess that no two human prize fighters (but are they human?) can give and take blows so rapidly.

The mocking bird, greatest of all the wildwood singers, has his own way of showing off his athletic nimbleness and grace. He somersaults backward in the midst of a staccato strain and never loses a note. Let some tenor try it in the opera one of these fine evenings.

All the woodpeckers climb the boles of trees not by stepping one foot at a time, but by jumping vertically. This may at first thought seem easy, yet a little reflection will disclose how difficult it is. The bird does not use its wings, and of course must spring upward and at the same time keep within reaching distance of the tree. Let a man try it with his two feet or two hands, no matter how well armed with spikes or claws, and he will, trained athlete though he be, certainly have a good, thumping fall for his pains. And more difficult still is the nuthatch's hopping headforemost down a tree stem, yet he does it with as much ease as you walk on the ground.

The great pileated woodpecker will hang to the underside of a branch by the grip of his toes, and hammer away for hour after hour without changing his position, when every powerful stroke is upward, and the heavy strain on his short legs is never relaxed.

Large migratory birds, the cranes, herons, geese, brant and the like, fly steadily night and day from Florida to the far North without rest, water or food, and at a rate of speed almost incredible. I do not know that they semi-annually go into training for their long flight, as our oarsmen and sprinters and football players must do before they can trust themselves to stand the strain of any, even the shortest, contest.

We have all read of the tireless flight of the albatross and have seen the pearl-white seagulls wheel about from daybreak to nightfall; but to me the pelicans seem to undergo the greatest strain that birds can bear. It makes me tired through sympathy to watch them feeding. They seem to fly so heavily while curving above the sea, and when they strike down at a fish it is the dash of a great hulking bulk into the water. For hours and hours up and down they go, a plunge and a rise, the constant flapping of enormous vanes, the ludicrous poising of a strangely overweighted head; it is a picture of stolid persistence, of activity almost prevented by bulk and ill shape. Yet watch a pelican with a good glass, and you will see that he is as sure of his strike as the kingfisher. His apparently awkward tumble into the flashing white caps is, after all, an amazingly accurate shot at a nimble mullet which he literally brings to bag.

The beautiful silver-breasted kite of our Southern States occasionally performs the feat of letting fall his prey and catching it again before it reaches the ground. A fine sight it is when he goes earthward from the clouds like a white bolt. I saw one drop a water snake which must have fallen fifty feet, wriggling and squirming, when the kite, so high that it looked like a forked-tailed swallow, shot down after it. With half closed wings it whistled through the air so swiftly that my eyes could scarcely follow, and struck the reptile just before it touched the earth. I have seen a red-headed woodpecker in the same manner catch a beechnut that he had let fall.—*The Independent.*

## KERNOT ON WIND PRESSURES.

PROFESSOR KERNOT, of the Melbourne University, has read a paper on wind pressures before the Australasian Association for the Advancement of Science. The author referred to the great inconsistencies appearing in engineering and architectural practice with regard to the wind bracing of exposed structures, and to the great variation in the anemometric results published by meteorological observatories. Some of these have recorded pressures or velocities corresponding to pressures of 90 or 100 lb. per square foot, while others report results only one-third as great. It was pointed out that these latter results correspond fairly well with common experience of railway carriages and chimneys, great numbers of which would overturn with pressures of not more than 30 lb. per square foot, and yet, as a matter of fact, do not overturn, and are publicly regarded as perfectly safe.

Professor Kernot has conducted experiments which tend to show that wind pressure varies with the square of the velocity; but he admits that further tests on a greatly extended range of velocities are needed. He has also devised an apparatus for determining the relative pressure of the wind on flat and curved surfaces of different figures. The apparatus consists of a screw propeller revolved in a tube at high velocities by means of a gas engine. In this way it was ascertained that the ratio determined by Stoney between wind pressure on the flat and on sloping surfaces, such as a roof, is just; but it was also found that this result applies only to roofs supported on their columns, under which the wind can blow freely. When the roof was placed upon a wall, as in an ordinary building, the wall deflects the current upward; greatly reducing the pressure upon the roof. If the wall is provided with a parapet of ordinary proportions, this effect is still more marked; the pressure being reduced to one-third of what it would otherwise have been. Experiments were made with the wind blowing in at the open end of a building having the sides and the other end completely closed; and it was found that the internal pressure tending to

lift the roof was equal to that of the wind upon a flat vertical surface. The pressure upon one side of a cube was found to be 0·9 that on a thin plate of the same area.

A lattice work in which the area of the openings was 55 per cent. of the whole area experienced a pressure of 80 per cent. of that upon a plate of the same area.

The pressure upon cylinders and cones was proved to be equal to half that upon the diametral planes, and that upon an octagonal prism to be 20 per cent. greater than upon the circumscribing cylinder. A sphere was subject to 0·36 of the pressure upon a thin circular plate of equal diameter. When a plane surface parallel to the direction of the wind was brought nearly into contact with a cylinder or sphere, the pressure on the latter bodies was augmented by 20 per cent. In conclusion, it was recommended that 20 lb. per square foot should be taken as the maximum wind pressure upon areas of not less than 300 square feet and 30 lb. for smaller surfaces in positions of full exposure.

## THE FIXED STARS.

By Prof. EDWARD S. HOLDEN, Director of Lick Observatory, California.

OUR knowledge relating to the stars has long needed the addition of one fact. One question has hitherto remained unanswered, namely, What are the actual dimensions of the fixed stars? or, What is the actual size of any single star? The distances of a number of stars are quite accurately known, considering the great difficulty and delicacy of the determination. The masses of a few stars are known, and these masses are not very different from the sun's mass. This was to be expected, as our sun is a star, and the stellar masses ought to be of the same order of magnitude as the sun's. The chemical constitution of very many stars is fairly well known from spectroscopic observations. That is, we know of many stars whether the vapor of iron is or is not present in the atmosphere, and so on for other substances.

The motions in the line of sight—the line joining earth and star—of many stars are also well known from spectroscopic observations; and their motions in directions perpendicular to the line of sight have also been carefully measured by comparisons between ancient and modern determinations of their positions. Hence the absolute motions in space of a considerable number of stars are fairly well fixed.

When we consider the enormous distances of stars in general (which are more than 200,000 times the sun's distance in all cases) and the comparatively feeble light emitted by even the brightest stars (never more than one seven thousand millionth of the sun's light), it must be admitted that much has already been learned concerning them. One datum is still lacking. What are their actual dimensions, or what is the actual diameter of any one star? This question has hitherto remained unanswered, and it is a fundamental one. As the stars in general are of the same order of magnitude as the sun, as has already been said, it is reasonable to conjecture that they are also of the same order of size. But conjectures are not satisfying in science, though one is often forced to be (temporarily) contented with them.

I should like to insert a parenthesis here, to say that the readers of articles on popular science ought to be continually on their guard against accepting the conjectures of the clever writer as if they were admitted and accepted results. It is perfectly justifiable to conjecture where we cannot (yet) know. Indeed, no active mind can avoid doing so. Science is advanced by trying the conjectures that arise, whether they be true or false. But the line between conjecture and conclusion should be sharply drawn and explicitly stated. The reader should try to hold himself in a critical and not in a credulous attitude, and the writer should always be ready to say, I know this to be so within an error of 5 or 10 or 50 per cent. After this long parenthesis, which appears to me to be well worth making, I return to the matter in hand. The actual dimensions of the fixed stars, How are they to be determined? It is impossible to fix these diameters with even the largest telescopes. The telescopic image of a star is not an absolute point, but it is a very small brilliant disk. Unfortunately the size of this disk is not a measure of the size of the star. The disk is really produced by the telescope; that is, the image of a brilliant mathematical point would be not a point, but a small disk. Mere seeing, as with a telescope, no matter how large, will not solve this question.

A very remarkable apparatus has lately been devised by Prof. Michaelson, of the University of Chicago, for solving this problem and others like it. The principle of the device is too abstruse to be explained here. It must suffice to say that it depends upon the measurement of interference bands produced by the light of a distant object. If this distant object has a sensible diameter, an easy measurement made upon the bands will determine the angular diameter of the object. If this experiment is made in the quiet atmosphere of a laboratory, where all conditions are under control, the instrument is capable of wonderful performances. When we come to use it in the open air upon stars and satellites, the unsteadiness of the atmosphere introduces very great difficulties indeed. Experiments of this sort have been made at Mount Hamilton by Prof. Michaelson himself, and they indicate that the problem of measuring the dimensions of the stars on this plan will be a very difficult one, though the trial is well worth making.

It is not long ago that the angular diameter of one star has been determined at Mount Hamilton by Prof. Campbell, using a method which is simplicity itself. This method has never before been applied to stars, though it has long been used in spectroscopy. The solar atmosphere contains the vapors of many different substances, each vapor being so highly heated as to give out light. Speaking generally, we may say that these vapors are arranged in the sun's atmosphere in the order of their densities. The heavier vapors lie lowest, and the lighter ones—as hydrogen—are highest. We must imagine the sun, then, as a central mass surrounded by many different shells of different substances—vapors. When we look at such a body with the spectroscope, we can obtain a separate image of each one of these shells, one at a time. The spectral lines of the various shells will have different lengths because the shells have different diameters. The lines of hydrogen are longer than the lines of iron, and hence we know that the hydrogen shell is larger than the shell of iron vapor. If the hydrogen lines are twice as long, then the hydrogen atmosphere rises twice as high as the iron vapor, and so on.

This observation is not very difficult in the solar spectrum, but it was entirely unexpected when Prof. Campbell found a star (1 m. 30 degrees, number 3,639) which was surrounded with an atmosphere of hydrogen gas of such enormous extent as to be measureable. The hydrogen shell surrounding the nucleus of this star has an angular diameter of five seconds of arc. When the distance of this star becomes known (and observations to determine the distance are in progress), this angular diameter can be expressed in miles. Then for the first time we shall know the actual dimensions of one of the fixed stars.

This discovery differs from the ordinary discovery in that it opens an absolutely new field of information. If a new comet is found, we have a new and valuable opportunity for collecting information about comets. Many comets are known, and it is likely that we can do no more than perfect our previous knowledge. The epoch-making discoveries are those in which new methods of research are invented, or in which old methods are applied to new subjects, as in this case. Here a new field of knowledge has been opened, and entirely new information is at hand. Mr. Lick's great telescope has been successful in finding many new and important things, but no one of them is more important than this, its latest achievement.—*The Graphic, Chicago.*

## GREENLAND AS A SUMMER RESORT.

IT appears that our old conceptions of Greenland, which have been in vogue so many years, must now be overhauled and altered to suit the style of modern style of thought. Here is Dr. Cook, of Brooklyn, who was surgeon of Lieutenant Peary's Arctic expedition of 1891-92, and ought to know something about Greenland, coming out with the announcement that the country notorious in tales of starvation and shipwreck, the country whereof the very name upon a dog day was once a chilling thing to think of—that country Dr. Cook declares is just the place for a summer resort. He has made arrangements to take one hundred pleasure seekers thither this summer. Furthermore, he promises that his party shall inspect the scenes of the adventures of Kane, Hayes, and Greely, and visit in its headquarters a real Arctic exploring expedition—that of Lieutenant Peary.

Set forth in cold print, the plan of opening Greenland as a summer resort is for a moment surprising; but whoever has read the narratives of late explorers must have been aware that the country was coming to something like this. It has long been known that at a certain season each year the coast of Greenland up to the seventy-eighth parallel is as easily accessible as the coast of Norway or of Alaska. As far north as Upernavik it is free of dangerous ice nearly all summer, and in July the pack in Melville Bay, dreaded by Arctic navigators, breaks up and floats south, leaving a clear passage across the east side of the bay to Cape York. Between Cape York and Smith's Sound is the so-called "North Water," open even in early spring. For two months, from the middle of July to the middle of September, a steamship may cruise along the sea wall of Greenland for upward of 1,500 miles without risk. Recent Arctic books have been tales, not of starvation and danger, but of comfort, health, and pleasure. Dr. Nansen, after his hard sledge journey is over, lies for days on the grass and revels in berries and basks in the sunlight. Professor Heilprin leads two expeditions to McCormick Bay, one to carry Lieutenant Peary there, the other to bring him back; both expeditions are jolly summer scientific excursions. Mrs. Peary spends one happy year on the shores of McCormick Bay, and returns to Bowdoin Bay, near by, for another. No one complains of suffering. In winter, of course, the temperature is low everywhere. In summer, it is low one hundred miles inland from the coast, upon the great snow desert, but near the sea and upon it the weather is delightful. Every one praises its warmth and its healthfulness. Nansen goes so far as to assert that the remarkable fascination which, as is well known, the Arctic regions have for every one who has visited them, is due chiefly to the invigorating quality of the air. "The Arctic is the most healthful zone in the world," he says.

If this view of the situation is the right one, if Greenland is a spot which one may visit without suffering, then undoubtedly it holds forth unique attractions to the pleasure seeker. Dr. Cook's excursion, if it turn out successful—and there appears no reason for doubting its success—will mark the beginning of an important epoch in the history of Greenland above Cape York; the epoch wherein civilization begins to put to use the territory which pioneers have cleared for it.—*Frank Leslie's Weekly.*

## DIATOMS.

*How to Find Diatomaceous Earth.*—Mr. W. A. Terry, of Bristol, Conn., sends the following to the *Microscopical Journal:*

It is asked how we know when we have found diatomaceous earth. It is, of course, impossible to be absolutely certain until the find has been examined under the microscope; still a collector of experience and good judgment will make few mistakes. The fresh water deposits are almost invariably covered by a layer of muck or peat. A light colored stratum below muck will be either *lime*, *clay* or *diatoms*, if it is not *sand*. Sometimes *all* mixed. If the material dries of a light gray or ash color and is also light in weight, it is almost certain to be rich in diatoms. If the deposit is heavy, it is mostly clay or exceedingly fine silicious dust: it is always well to examine all such deposits under the microscope, and, if not rich, they may contain rare varieties.

The marine deposits underlying the peat of all salt marshes of the Atlantic coast always contain diatoms; in some localities these are comparatively rich, and frequently contain deep water forms. The diatoms are not equally distributed through these deposits, but are apt to lie in thin streaks or in pockets; and strata holding shallow water forms and those containing deep water kinds are sometimes in close proximity. Where ditches have been dug through these marshes for drainage, material containing very interesting varieties is frequently thrown up. Shallow water kinds usually predominate near the surface, and below are streaks of deep water forms alternating with those of brackish water down to a depth of over twenty feet in many places.

On the New England coast, it is not very unusual to find these deposits to be from thirty to fifty feet in thickness. Where the deposits were laid down by strong tidal currents, few diatoms will be found. They deposit in eddies and basins after the coarse sand has been left behind.

These hints will be sufficient to guide the efforts of persevering and intelligent investigators in search of diatomaceous earth; but they must understand that tiresome and disagreeable labor is inevitable, if they would win success. At some future time I will give more detailed instructions.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## LOUIS KOSSUTH.

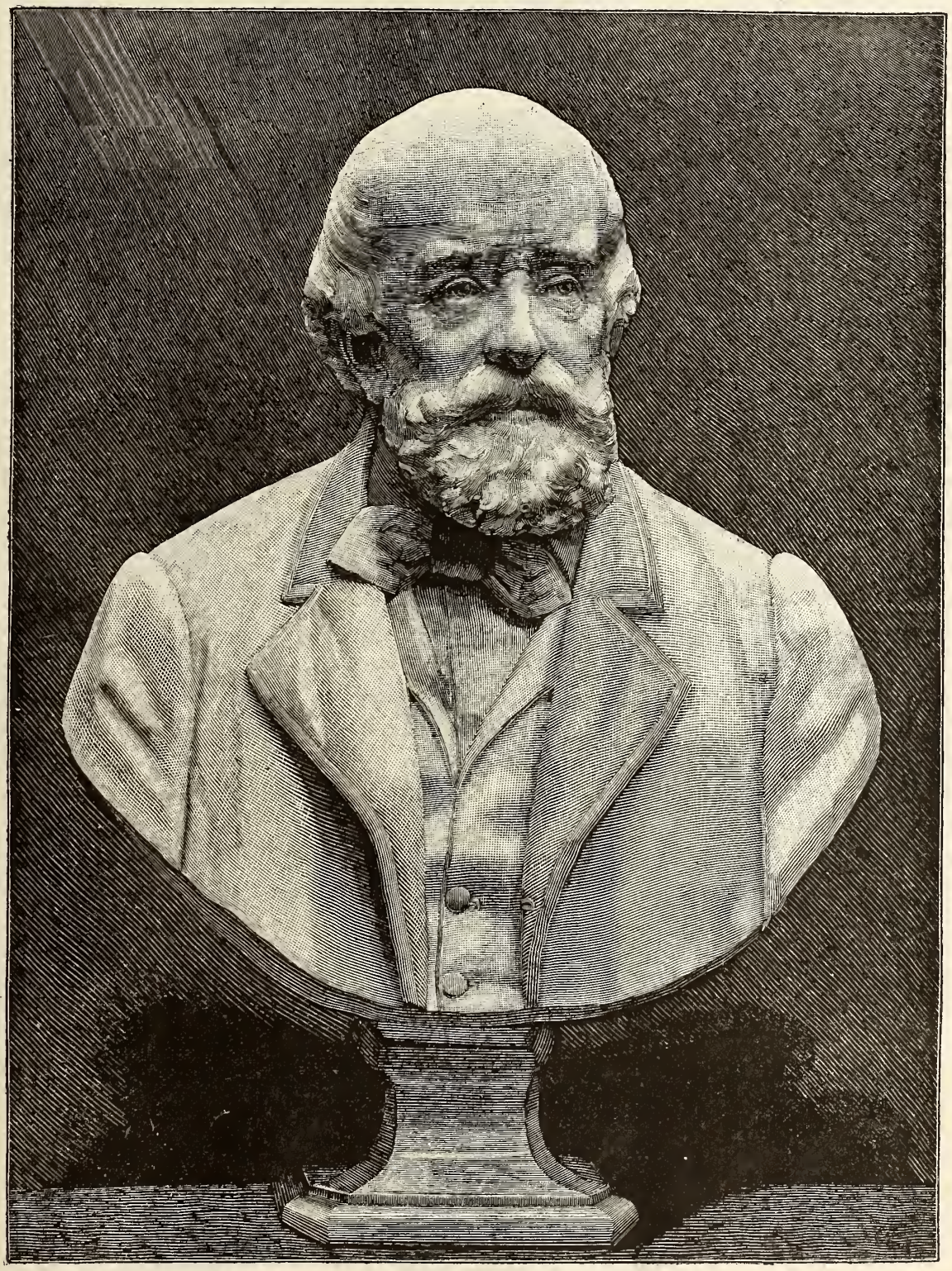
LOUIS KOSSUTH was the oldest statesman of our times, for he was almost ninety-two years old when he died, on March 20, in Turin, where he had lived for many years. Until quite recently he had led an active life, working diligently on the four volumes of his reminiscences, which he published under the title, "Meine Schriften aus der Emigration," in Hungarian, German, and English.

The independent parties looked upon him as their real leader, and the chiefs often turned to the old "ex-dictator" when there were difficult or critical questions to be settled. The numerous long papers that he wrote on political subjects revealed the wonderful vigor of his mind, and also the enthusiasm and liberality with which this remarkable old man still thought and spoke on the subjects that had stirred him in his youth. In this respect he reminds one of Alexander von Humboldt, who, when ninety years old, was intensely interested in the progress of the political as well as of the religious world.

Kossuth corresponded with many famous statesmen, savants, and authors, and has left a wealth of interesting letters, which, it is to be hoped, will be published. When on his death bed he gave to his country his valuable library, which contains much that will be very important in writing the history of the nineteenth century.

During his unexpectedly long life Kossuth remained true to a sentiment that he expressed in a letter written from London after the treaty of Villafranca: "The blessing of success remains with God; man can only endeavor sincerely to do his duty."

We publish herewith an engraving, for which we are indebted to our honored contemporary, the *Illustrirte Zeitung*.



LOUIS KOSSUTH.

## THE ART OF READING BOOKS.*

By J. E. C. WELLDON.

THE cities and parishes which have taken advantage of the Public Libraries Act seem to me to have been wise in their generation. They have understood the civilizing and refining power of literature. They have seen in it the antidote, or one of the antidotes, against what is mean and materialistic in modern life. It is related by the historian Diodorus Siculus that over the doors of the great Egyptian Library of Osymandyas—the king who gave his name, as you may remember, to Shelley's sonnet—were inscribed the Greek words *ψυχῆς ἰατρεῖον*, which mean "the sanatorium of the soul." For the soul may be valetudinarian like the body; and, like the body, it has need of a bracing discipline. You can never cure any human ill by preaching against it; you must supplant it by some wholesome vital influence. The "expulsive power of a new affection," as Cardinal Newman has called it in one of his sermons, is the only means of driving out old affections. No doubt he was thinking of religion, and he meant that one religious faith can be eradicated only by another; it is proof against mere denial. But one taste or habit also yields only to another; it is not destroyed, but supplanted. And if you would draw men away from the public house or the "bucket shop," and from such associations as are congenial to these places, you must awaken in them higher tastes and aspirations, and of these the love of reading is the chief. May I commend to you a passage taken from a book which is not so popular nowadays as it was once, Burton's "Anatomy of Melancholy"? You know he treats first of the causes of melancholy among men, and then of its cure. He says: "So sweet is the delight of study, the more learning they have (as he that hath a dropsy, the more he drinks the thirstier he is), the more they covet to learn, and the last day is *prioris discipulus*," and then he relates the following story, which is worth remembering: "Heinsius, the keeper of the library at Leyden, in Holland, was mewed up in it all the year long; and that, which to my thinking would have bred a loathing, caused in him a greater liking. 'I no sooner (saith he) come into the library but I bolt the door to me, excluding lust, ambition, avarice and all such vices, whose name is idleness, the mother of ignorance and melancholy herself, and in the very lap of eternity, among so many divine souls, I take my seat with so lofty a spirit and sweet content that I pity all our great ones and rich ones that know not this happiness.'"

It would be unsafe, perhaps, to predict that many who hear me will use this library in the spirit of Heinsius. But the love of books is one of the greatest blessings in life. Only you cannot love a book all at once; with books, as with men and women, love is the privilege of long intimacy. It is only when books have been read and reread, and, as it were, clasped to the heart, that they become, in Macaulay's words, "the old friends who are never seen with new faces; who are the same in wealth and in poverty, in glory and in obscurity." To know even one book in this way is to gain a spiritual revelation. It is thus that the study of the Bible, even as literature, has so profoundly affected English life and thought; for it often seems to me that the most sharply drawn of all dividing lines in English history is between reading and non-reading England, or, in other words, between England without the Bible and England with it. Our forefathers were contented with one book; we are sometimes not contented with many.

Gibbon says, in his autobiography, that he would not "exchange his early and invincible love of reading for the treasures of India." But modern education has so far equalized the social classes of the community that the pleasure of reading, which at the beginning of this century was enjoyed by a small cultivated minority, has already become, or is fast becoming, the boon of all.

Did it ever occur to you to realize what a change the universality of reading and writing, which has only come to be true since the Education Act of 1870, has made in the English-speaking world? It is not the only change which distinguishes the nineteenth century from all the preceding centuries; for I suppose (to take one example) there is no reflection more curious than that the means of locomotion should have remained practically the same from the time of the Pharaohs until the reign of King George the Fourth, and then should have been revolutionized in a day. But fifty years ago a girl who left her village in the country for domestic service was cut off from her home, her family, and all the associations of her past life; she could not write to her parents, nor they to her; and if they did write, or get somebody to write for them, it was impossible for her to read their letter; she might be ill, she might be ruined, she might be dead, and the probability was that nobody who felt a natural interest in her story would know anything about her.

How different it all is now, when, by the gentle arts of reading and writing, and especially of photography, that beneficent means of keeping the memory of our

* An address delivered on January 4 at the opening of the Kilburn Public Library.

absent friends and children alive within our hearts, there is not an incident of her life, wherever she may be, but it is familiarly known to all the members of her family! Dreary, indeed, was the old age of the poor fifty years ago, without books, without newspapers, without any broadening interests. But to-day, even where the parents cannot read, their children are their interpreters of human things, and whatever pain the parents may feel, as is not unnatural, in the consciousness of their own inferiority, is more than compensated by their honest pride in their children's culture.

You, ladies and gentlemen, to whom this library will offer in future the resources of its many thousand volumes, will all be readers; and I do not see how I can better utilize the few minutes in which I have the honor of addressing you than by trying to give you such advice as will help you to read wisely. For most of those who employ this library will not be students; they will not have unlimited time for reading books; it is, perhaps, only for a brief hour when the toil of the day is done, that they will think of getting literary information. Sydney Smith said once: "Live always in the best company when you read. No one in youth thinks on the value of time. Do you ever reflect how you pass your life? If you live to seventy-two, which I hope you may, your life is spent in the following manner: An hour a day is three years; this makes twenty-seven years sleeping, nine years dressing, nine years at table, six years playing with children, nine years walking, drawing and visiting, six years shopping and three years quarreling."

It may be permitted me to hope that you will not spend your life—at least the ladies will not—altogether in this way, partly because you will enjoy the benefits, moral as well as intellectual, of this library. Yet, however economical of your time you may be, it will be a practical difficulty for you or for any one in the present day to cope with the vast and ever-increasing mass of literature. It is perhaps three thousand years since the invention or use of writing, and during that time the writers of many nations and many ages have been pouring out books, until the stream of literature has swollen into a cataract—a very Niagara of books—which sweeps or threatens to sweep away the delights of civilization before it. The reader of to-day aspires to know something of the thoughts which the wisest of men in all the periods of history have expressed upon the most vital subjects of human interest. He cannot, therefore, acquiesce in narrow reading. He must read widely, not in English only, but in many languages, or in translations from them. He must cultivate a cosmopolitan literary spirit. But life is short; and alas! art is long and is becoming longer; the number of books which a busy man can read in a year can hardly at the most exceed fifty; and, considering what a strain is now put on the most absorbing literary appetite, I am at a loss to see how any man who lives at the end of the twentieth century will deserve to be called educated at all. For books do not become shorter as they become more numerous, it rather seems that they increase in bulk and volume; for Gibbon wrote the history of the "Decline and Fall of the Roman Empire," a period of fifteen hundred years, in eight octavo volumes, and a living historian occupies the same number of volumes with the history of less than thirty years in England alone.

In these circumstances, looking to the accumulating mass of ancient literature, and the ever-accumulating mass of literature which is new, busy men have hit upon various methods of arriving by a kind of short-cut at literary knowledge. One method has been to choose an arbitrary number of the best books, and to concentrate attention upon them. Sir John Lubbock is, I think, responsible for the original list of the hundred books which are most widely approved, and he, if any one, is competent to make the selection; but the number has been found too large, or it has not been always accepted, and so it has been reduced by various authorities until it has come to be supposed that there is no difficulty in determining a number, however small, of the best books in the world, and I remember that a lady wrote to me not long ago asking me to name the *three* best books, exclusive of the Bible. Then, again, it has been thought possible to acquire an insight into literature by selections or extracts from famous books, or by abridgments of them. It sometimes happens that a person reads a review of a book and imagines he has done as much as if he had read the book itself. But upon the whole I would venture to give you a serious warning against all extracts and abridgments, whatever they may be. The author of a book has a right to demand that, if it is read, it should be read as he wrote it; it is not the same book when it is cut up or boiled down. And as to reviews, they are not the book at all; they are no more the book than a man's clothes are the man himself; and, if you have ever written a book and seen it reviewed, it is only too likely that you have experienced a sense of astonishment at observing that, though you may not have possessed a complete knowledge of the subject with which it deals, yet at least you knew more than the reviewer.

There is an art of reading, I think, as well as an art of writing. It is not enough that people should be told to read; they must be told how they ought to read, and what. For in all life it is not the work which men have to do that makes the difference, it is the way in which they do it. A man may do little or nothing and be always at work, or he may administer an empire and be at leisure. Let me suppose, then, that you have an hour a day and no more to expend upon literature.

There are two perfectly different ways of reading a book. It is curious that we often speak of reading as if it were always the same thing. But nobody, after consideration, will maintain that it is possible or necessary to read "The Proverbs of Solomon" and "King Solomon's Mines" in the same way. Bacon, in his "Essay upon Studies," puts the matter clearly: "Some books are to be tasted, others to be swallowed and some few to be chewed and digested; that is, some books are to be read only in parts, others to be read, but not curiously, and some few to be read wholly and with diligence and attention." It is fair to say that there will be a great saving of time if the number of books which require to be "chewed and digested" is made as small as possible.

I do not deny that the habit of concentrating the full power of the mind upon every chapter and page of a book is a discipline of very high value. The study of books written in a foreign language, whether ancient or modern, forms this habit and is principally valuable as forming it. In fact, it may be doubted if a person ever reads his own language in such a way as to appreciate its full meaning. But the great majority of books in a public library do not require and do not deserve to be so read. In looking at some statistics of the books taken out of one of the public libraries by the working classes, I notice that the class of books which is in most request is novels, and the class which is in least request is sermons. It is not for me, being a clergyman, to declare with what degree of attention sermons ought to be read. But I confidently say that nearly all novels admit of light and rapid reading. Where the point of a book lies in its narrative rather than in its style or substance, the process of "tearing out its heart," as it has been called, is the secret of alleviating labor. To some extent the same is true of history, and especially of that fascinating form of history, biography. You do not want to know or remember all the incidents; you want to grasp the general *contour* of the country (if I may use a geographical expression), not to be able to name every height and valley in it. Nor must it be forgotten that you have made an acquisition of knowledge which is well worth having, if your reading enables you, not indeed to produce your facts at an instant's call, but to discover where they are to be found and what they are, when leisure is given you. It appears to me, then, that one book in twenty should be read scrupulously; the rest may be read, so to say, *currente oculo*. But it is more important to read wisely than to read widely. Intellectual health, like physical, depends not upon the amount of food consumed, but upon the digestion.

And, if it be necessary to decide what books are they that should be read, not with the eye only, but with the soul, they will be such books as, in the German phrase, have been "epoch-making," and have exercised a lasting influence upon the current of human thought. They are not many; but in them is contained the essence of all literature. In religion, the Bible, and these two books which are most closely founded upon it, the "De Imitatione Christi" and "The Pilgrim's Progress;" in poetry, the writings, or some at least of the writings of the four great masters—Homer, Dante, Shakespeare, Goethe—who guard the portals of human sentiment for all time; in history, Thucydides and Gibbon as respectively illustrating the perfection of historical science in miniature and on a scale of majestic dignity; in philosophy, Plato's "Republic," which by the genius of the late master of Balliol has been made an English classic, and Pascal's "Pensées;" in political science, Aristotle's "Politics," Montesquieu's "L'Esprit des Lois," and Adam Smith's "Wealth of Nations;" in science, Bacon's "Novum Organum," Newton's "Principia" (if it be intelligible to you), and Darwin's "Origin of Species." These are all, or nearly all, the books that have been "epoch-making," and to read these will be to enter, however humbly, into the temple of knowledge and truth.

There is an exhilaration in the thorough study of noble literature. It gives tone and courage to the mind. The famous novelist George Eliot says it was her wont to seek inspiration for her writings by daily intercourse with the good and great writers of the past. May you learn the satisfaction of living, if but for an hour, each day in the company of the good and the great!

For the last word that I will say in the hope of enabling you to make the best use of the library which is now opened, is that you will do well if you read something that is worth reading every day of your lives. One hour a day amounts to many weeks in a lifetime; and it is not by doing great things now and then, but by doing something continually, that the best and most lasting results are attained. "The modern university," says Mr. Carlyle somewhere, "is a library." It is a university in which you all may graduate. It is a home which stands above the stress and pain of evil days. For literature, like virtue, is its own reward; and none but they to whom that reward has been given know or imagine how unspeakably great it is.—*National Review.*

## CONSTANTINOPLE.

Of all the cities of Europe the New Rome of the Bosphorus, in its power over the imagination of men, can yield the first place to none save to its own mother, the Old Rome of the Tiber. And of all cities of the world she stands foremost in beauty of situation, in the marvel of her geographical position, as the eternal link between the East and the West. We may almost add that she is foremost in the vast continuity and gorgeous multiplicity of her historic interests. Those who approach Constantinople from Greece, as all men should, have sailed through that long panorama of island, mountain and headland which the Ægean Sea presents, past "Troy town" and the unknown home of its minstrel; and every rock recalls some tale or poem for the three thousand years since European thought and arts rose into being across those waters. The Hellespont has been passed with its legends and histories, and the Sea of Marmora with its islands of marble, its rich shores and distant ranges of mountain—and as the morning sun touches the crescents on her domes, the eternal city of New Rome bursts into view, looking on the east and the south across the blue waters of Propontis and Bosphorus, with her seven hills rising toward Europe one behind the other, each crowned with cupola and minaret, amid arcaded terraces, and groves of acacia, myrtle and cypress.

This glorious vision, if not the most beautiful, is the most varied and fascinating of its kind in Europe. Some prefer the Bay of Naples, or the Bay of Salamis, or of Genoa; but neither Naples, nor Athens, nor Rome, nor Genoa, nor Venice, have, as cities, anything of the extent, variety, and complexity of Constantinople, if we include its four or five suburbs, its magnificent sea landscape, its bays, islands, and mountains in the distance. For Constantinople does not stand upon an open sea like Naples or Genoa, but on a great marine lake with its shores, vine-clad hills, headlands and pearly mountain ranges in the far horizon. Like Athens or Venice, it has a seaport without an open sea outside. And as a city, it is vastly more grand and varied than Venice, Athens, Florence, or Edinburgh. Hence, Constantinople combines such sea views as we find round the western islands of Scotland or of Greece, with the summer sky and vegetation of Italy, and the mountain ranges which fill the horizon from the plains of Lombardy.

Was it more beautiful in the age of the empire than it is to-day? Perhaps from a distance, from the sea, the Stamboul of to-day is a far more striking sight than the Byzantium of the Cæsars. The minarets, an eastern and Moslem feature, are the distinctive mark of the modern city, and do much to break the monotony of the Byzantine cupolas. There are four or five mosques which repeat and rival the church of the Holy Wisdom, and some of them have nobler sites. Nor were the towers and battlements of ancient architecture to be compared in beauty and in scale with those of mediæval and Moslem builders. But the city, as seen within, in the Isaurian and Basilian dynasties, we may assume, in the five centuries which separate Justinian from the first crusade, must have greatly surpassed in noble art, if not in pictorial effect, the Ottoman city that we see. The enormous palace and hippodrome, the basilicas, churches, halls, and porticos with their profusion of marble, mosaic, bronzes and paintings, their colossal figures, obelisks and columns, the choicest relics of Greek sculpture, the memorial statues, baths, theaters and forums, must have far surpassed the decaying remnant of Stamboul which so often disenchants the traveler when he disembarks from the Golden Horn.—*Frederic Harrison, in the Fortnightly Review for April.*

## WHAT I DON'T KNOW ABOUT ELECTRICITY.

By George Cutter.

I believe in electric lighting and cooking in isolated country homes by private plants and expect quite an increase in this line of work in this country in the near future. "I don't know" the best kind of a plant to recommend for this kind of work. So much has been done in this line in England that we could surely learn some good lessons by a careful study of domestic plants over there. I had the pleasure of assisting in the installation of one domestic plant in England, but it was not of a nature to afford much information for our work in this country. The plant cost $10,000 and was not planned for economy in working. A special house was built for the purpose and in this were installed steam boiler, engine, dynamo, storage batteries, and an array of testing instruments that would be frowned upon quite forcibly by an American electrician, as these private plants must be planned for practical work without expert attention and not as testing laboratories.

I have built a dynamo house by my suburban home and am puzzled what to install in it. When built it was my intention to install a boiler and engine well equipped with automatic stoker, regulators, etc., which would keep everything in proper working shape for runs of ten hours or even more. These automatic devices are all easily applied and would tend to develop domestic plants to such a degree of perfection as to lead to their adoption by many householders. I intend to pipe the steam to a system of indirect radiation for heating the house, and believe the cost of operating my plant, using exhaust steam for heating my house, would really be very little in excess of the cost of heating the house direct. Probably the best line of work for these domestic plants will be in this direction—studying simplicity and economy and making a special feature of automatically performing all the operations, so that a very little inspection and attention will be required. Of course the ideal plant involves the use of storage batteries, thus tending to make the first cost rather excessive. It is not absolutely necessary to use storage batteries, and I am not sure but the perfection of the automatic devices mentioned will render the expense of storage batteries very questionable, especially if cooking and other domestic work is done by electricity. The plant can then be operated all day and evening, the engine being merely placed in the path of the steam from the boiler to the heating system of the house.

Bearing in mind that this steam engine is almost a toy in such a case, two or three horse power generally being sufficient and ten horse power very large, such plants should be developed complete by the parties who intend to push their sale, and furnished like complete bell outfits "ready to put up." The buyer cannot buy dynamo in one place and engine in another, etc. Imagine the perplexities of a man who makes it known that he intends to install a lighting plant in his house. The number of "best" and "only correct" devices for each separate part of the plant that would be presented would overwhelm a giant intellect and probably cause the party to feel he had found a great den of thieves from none of whom he could learn the truth.

A gas engine is also a fine method of operating private plants for those residences that have gas in them. Even those that have private gas plants can send the gas through a gas engine to make electric lights and get a certain amount of light for less expense in coal than by burning the gas direct for light. Gasoline and kerosene engines are probably the cheapest of all for small powers and are easily installed and operated. My reason for hesitating about installing the steam engine outfit in my house is not because of a doubt of its being the best, but because of a little sentiment, viz., a desire to play with the problem on lines that might develop more practical and simple means of domestic lighting and cooking. Some fine day in the near future we are going to learn how to produce electricity direct from crude materials at much better efficiency than through the boiler and engine. Possibly a primary battery that will yield valuable by-products may come before the cheap electric generator above hinted upon, but these batteries are not likely to help much in isolated residence lighting, as the owners will not care to become by-product dealers. The makers of such batteries could of course buy all the valuable by-product. Primary batteries without valuable by-products can be made so as to be useful for residence lighting and at a cost that will not be prohibitive. And my present hobby lies in this direction. It is a promising field to work in.

Large thermopiles (furnace generators of electricity)

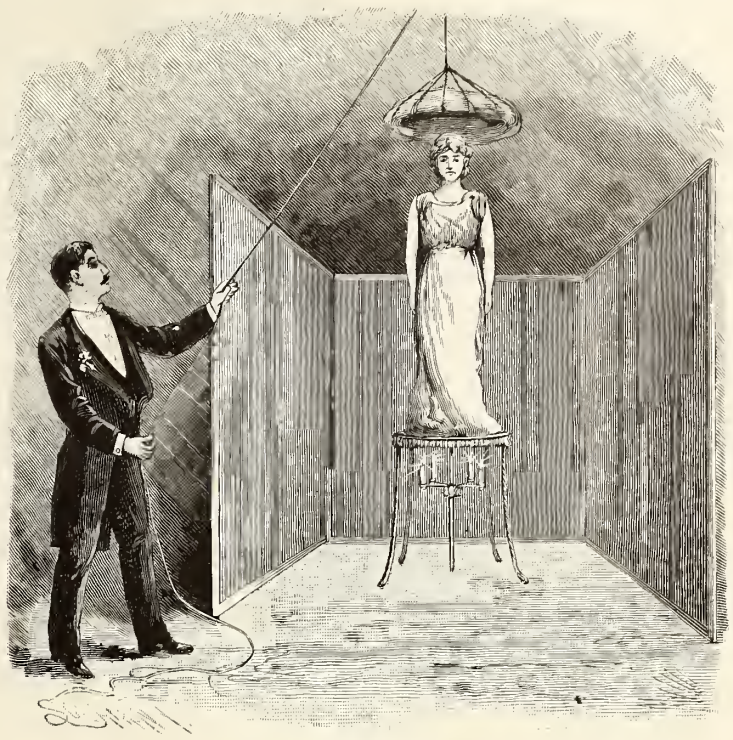
afford an equally interesting field of work, but probably less promising than primary batteries. Available water power is not open to discussion, as the lucky owner of a water power large enough to do his lighting and cooking by electricity is unquestionably in possession of the means of procuring the greatest of house comforts, natural gas not excepted. A great field for this work is open to the enterprising engineers in the irrigation regions of the West. Windmills come in for the last method to be suggested in this paper, and to be passed over lightly, as they are simply not in the race at all. If a moderate breeze would develop enough power without a giant windmill, or if strong breezes would blow with such regularity as to afford a fair daily average, this method would be the prize winner. But as a gentle breeze does require an enormous wheel for the power, and as stiff breezes are very irregular and often much too strong, thus using up the total mileage per month in a few storms, the windmill is simply not in the race.—*Electrical Industries.*

## A CREMATION SCENE.

AMONG interesting things to be seen at the Eden Musee, in this city, perhaps one of the most curious and at the same time scientific is the weird spectacle entitled "She," exhibited by Powell, the well known illusionist, and suggested by the Cave scene in Rider Haggard's celebrated novel "She."

In this scene a beautiful young lady mounts a table arranged in an alcove formed of a folding screen. Above the victim is suspended a cylindrical cloth screen. The screen is lowered to the level of the table, completely inclosing the subject. The table apparently has four legs, and four candles shown beneath it indicate that the space underneath the table is open and clear. The cylindrical screen is shown to be entire, with openings only at the upper and lower ends, and no openings are seen in the folding screen which partly surrounds the table. Upon the firing of a pistol the occupant of the table is ignited, and smoke and flame bursting from the screen indicate that the work of destruction is going on within. When the fire is burned out the screen is lifted, and nothing remains upon the table but a few smouldering embers and a pile of bones surmounted by a skull. Close observation does not reveal any way of escape for the young woman. It is, however, obvious that the magician cannot afford to sacrifice such a subject every evening, and the spectators are forced to conclude that the whole affair is a very clever trick. In fact, it is simply a modification of the beheaded lady and numerous other tricks based upon the use of plane mirrors. The table has but two legs, the other two which appear being simply reflections. The central standard supports but two candles, the other two being reflections. Underneath the table, and converging at the central standard, are arranged two plane mirrors at an angle of 90° with each other and 45° with the side panels of the screen. By means of this arrangement the side panels, which are of the same color as the central or back panel, are reflected in the mirror and appear as a continuation of the back panel. The triangular box, of which the mirrors form two sides, has a top composed in part of the table top and in part of mirror sections for reflecting the back panel, or with a covering of the same color as the back panel.

The operation of the apparatus is now obvious. When the victim is inclosed by the cylindrical screen, she immediately escapes through a trap door in the table top, places the bones and the fireworks upon the table, and at the firing of the pistol ignites the latter and retires, closing the trap door after her.



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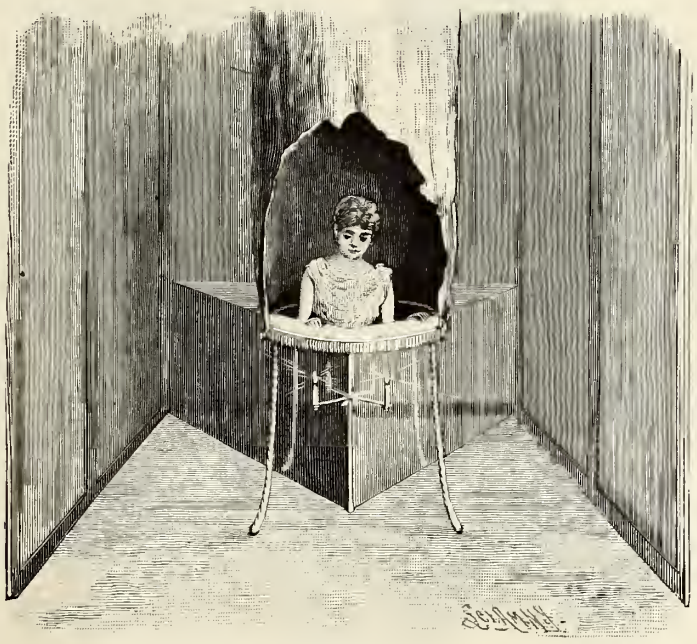
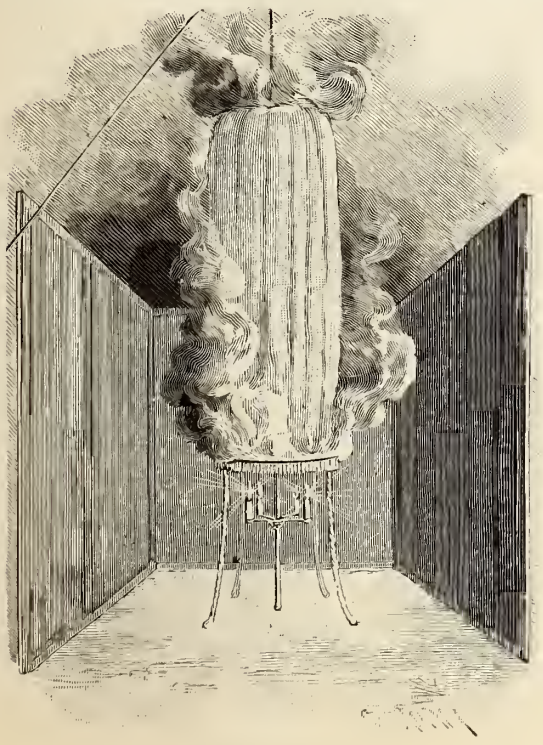
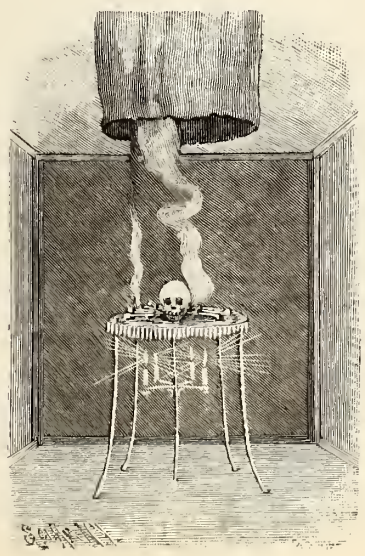


THE ESCAPE.



THE BURNING.



THE FINISH.

## THE USES OF BORAX.

By E. L. FLEMING.

BORAX is a white, crystalline substance, peculiar to the mineral kingdom; it is a very mild alkali, of a pleasant, sweetish taste, and is not injurious to the human system; it is freely soluble in water; its solution acts as a solvent for resins, albumens, fatty acids and certain organic bodies that are not soluble in water alone; but it does not appear to attack fibers, membranes, tissue, or skin. In the crystalline state or in solution, it is very easily decomposed by such acids as tartaric acid or acetic acid; but in its calcined or anhydrous state, when fused, the boracic acid it contains acts as a more powerful acid than even sulphuric acid.

Borax, in the crystalline state, contains 47¼ per cent. of its weight of water, to which it tenaciously adheres at the ordinary temperature of the atmosphere, time seeming to have very little effect upon its character. At the boiling point of water it slowly parts with nearly the whole of this water, and if the process be conducted quickly, at a still higher temperature, the borax swells to several times its size, becoming a body of a light and porous nature, which may be crushed to a compact powder.

At a higher temperature than 450° Fah., it melts to a clear glass, which remains transparent on cooling. Though the applications of borax are not generally known, as a fact this interesting and valuable salt will be seen to be utilized in different ways by several industries.

For goldsmiths a special grade of borax is prepared, called jeweler's borax, in pieces as solid and free from cracks as possible, so that when rubbed on a slate with water it is not liable to fall to pieces but will gradually wear away until too small to handle conveniently, when the small pieces are put on one side, to be used as a flux in melting or collecting.

An enameled coating for cast iron and steel as well as copper is made by fusing on the metal a mixture of quartz, feldspar, clay and borax, and then covering it with a glaze containing borax. It is thus extensively used in the manufacture of enameled iron mantel pieces, made to represent the rarest marbles, and in the great variety of enameled signs and hollow ware. Borax is also used in conjunction with infusorial earth for lining fireproof safes, for being a salt that contains nearly 50 per cent. of its weight of water of crystallization, with which it parts at a high temperature in the event of fire, the steam arising from the heated borax permeates the books and papers in the safe, and prevents their being burned.

For this purpose it is superior to alum, which is an acid salt, and has a tendency to corrode the iron. At a red heat the boracic acid in borax readily dissolves and unites with metallic oxides, forming a fusible glass, which property renders borax of great use in conjunction with other fluxes, for certain mineral and metallurgical processes.

In brazing copper it is used for cleansing the parts to be joined, on account of the property it possesses of dissolving the oxides that form a film upon the metal. It is very extensively used in the manufacture of copper pipes and for other purposes.

In welding iron and steel together it answers the same purpose. Machinists and others use the crystal for chilling the iron to the right temperature, for the purpose of casehardening or tempering different portions of machinery or implements to the desired degree.

Borax has recently been applied with considerable success to the manufacture of optical glass at Jena. This glass has very high refractive properties, and has been very successfully applied to the manufacture of lenses for microscopes and for photography.

Borax is now used in glazing china and earthenware so extensively all over the world that the consumption in these industries, at the present time, exceeds any of the others. The principle adopted is to form a fusible glass of borax and other materials, and fuse it on to the baked earthenware. Many formulæ have been published of the composition of this frit, but almost every large firm have their own formula.

In the manufacture of Parisian cement the borax is

added for the purpose of enabling cement, when set and moulded, to take a polish.

In the chemical industries it is used in the manufacture of soap, colors, drysaltery, and cosmetics; also in photography and timber preserving.

There are many kinds of borax soap. From all accounts its use in this industry arose from the fact that the linen of Holland and Belgium became celebrated on account of its superior whiteness, in the cleansing of which borax was used as a soap powder; and hence we find that dry soap, soft soap, and toilet soaps are now made with it.

In the manufacture of colors borax is used, and in the preparation of borate of chromium, a pale green powder, and borate of copper, a darker green. These are used as substitutes for arsenical green in painting and dyeing.

In drysaltery it is used in the shape of borate of lead and borate of manganese. Both these products are used in the manufacture of varnish (as driers). The borate of lead is used for the palest varnishes, and the borate of manganese in other varnishes.

As a cosmetic it enters in the composition of many preparations for the hair, the face, and the hands.

Photographers use it in the toning bath to govern the action of chloride of gold, which is dissolved in conjunction with it.

In the preservation of timber it is used for dissolving the albuminous resinous matter, or the sap, which readily decays, leaving only the tough fiber.

Borax dissolves caseine, forming a substance which can be used as mucilage.

In silk it serves for dissolving the glutinous matter adhering to raw silk.

In calico printing it is used for fixing certain colors as a mordant.

Laces, muslin, tulle, and other light fabric steeped in a solution of borax are rendered fireproof.

Hat manufacturers use borax for dissolving shellac to form a stiffening for felt hats made of wool. A weak solution of borax is used after the felt body is proofed, to wash from the surface any excess of stiffening not required upon the face of the felt.

Candle wicks are prepared with a solution of borax. Its use is to cause the wick to curve in burning, and at the same time to vitrify the ash. It also prevents the wicks from burning too rapidly, and obviates the necessity for snuffers.

In the leather industries it is used in curing and preparing skins by leather dressers and leather dyers.

It is used as a mordant in dyeing leather with aniline colors. And also in polishing, a little borax in the blacking or coloring is added to enable the iron used in polishing to pass freely over the leather. It prevents the iron sticking and increases the glaze.

Pork packers use powdered borax for sprinkling over hams and bacon. Thousands of tons of meat are thus annually preserved in America.

Fish curers use a mixture of boracic acid, alum, and salt for keeping herrings fresh. The principal seat of this industry, so far, has been at Hangoesund, near Stavenger, in Norway.

Having thus practically demonstrated its usefulness, let us turn our attention to the sources from whence it comes. England has no borax fields or mines, and at present the material, either in the manufactured state or that from which it can be manufactured, comes from Thibet, Italy, Chile, California, and Asia Minor. Thibet is the most ancient source, and, under the name of "tincal," borax is brought from the neighborhood of Yam-dokcho to Calcutta, from which port the source of origin is distant between four hundred and five hundred miles almost direct north. At the present time there is railroad communication as far as Darjeeling, or a distance of three hundred miles.

There is also a borax refinery at Jagadhri, thirty-seven miles southeast of Umballa, in northern India—all the borax which is exported from India being brought from the trans-Himalayan region.

The manufacture of borax, as far as England is concerned, divides itself into two classes—the manufacture of borax from boracic acid and that from sesquiborate of lime and double borate of lime and soda.

The mere refining or recrystallizing of crude borax requires no skill at all. The manufacture of borax from boracic acid imported from Italy involves several processes. The sulphates of ammonia and magnesia have first to be washed out of the crystallized acid, and this is effected by reason of their superior solubility. The boracic acid is then boiled in large iron pans, with the requisite amount of carbonate of soda, the impurities allowed to subside, and the clear liquor run to large iron vats to crystallize. This first borax is not pure enough for commerce, and requires a second crystallization.

The impure borax liquors are boiled down, and, upon reaching a strength of 60° Twad., or 1·300 specific gravity, are allowed to recrystallize and throw down a further crop of borax. Before the mixture reaches a temperature of 80° Fah. it is drawn off into other vats to allow the sulphate of soda to crystallize out, and, finally, the liquor is raised to the boiling point, and concentrated, in order to get rid of the common salt.

Borax manufactured from boracic acid is liable to be tinged with various colors, such as black, green, or yellow, on account of impurities contained in the acid or the soda ash, and are due to the presence of sulphides or oxides of iron. In order to overcome this difficulty the borax is bleached when in a state of solution.

The manufacture of borax from boracite, colmanite, or ulexite presents a new feature that does not appear in the manufacture from boracic acid, and that is, that when any of these minerals are reduced to a state of the finest powder, and boiled with carbonate of soda, what is known as borate of soda, as well as biborate of soda, is formed.

The biborate of soda or borax crystallizes out in the ordinary way, but the borate of soda remains as a thick sirupy liquor, which has to be decomposed either with carbonic acid, boracic acid, or bicarbonate of soda. If this is not done, loss is apt to occur, and the full strength of the mineral is not obtained.

With such abundant supplies of borate of lime throughout the world, it becomes a question of transporting the boracic acid it contains in as concentrated a form as possible, especially in those regions where the quality is but poor, and, therefore, many plans have been devised. One of the simplest is what is known as the sulphurous acid process, and this is to be preferred to others on account of the small quantity of sulphur required to extract the boracic acid.

The process consists in burning sulphur, and injecting the sulphurous vapors into the decomposing vessel, where the borate of lime is kept in a state of agitation and suspension in water.

Only one ton of sulphur is required to produce five tons of acid, and the saving effected in cost of transportation, where it takes two or even three tons of borate of lime to produce a ton of boracic acid, requires no recommendation.

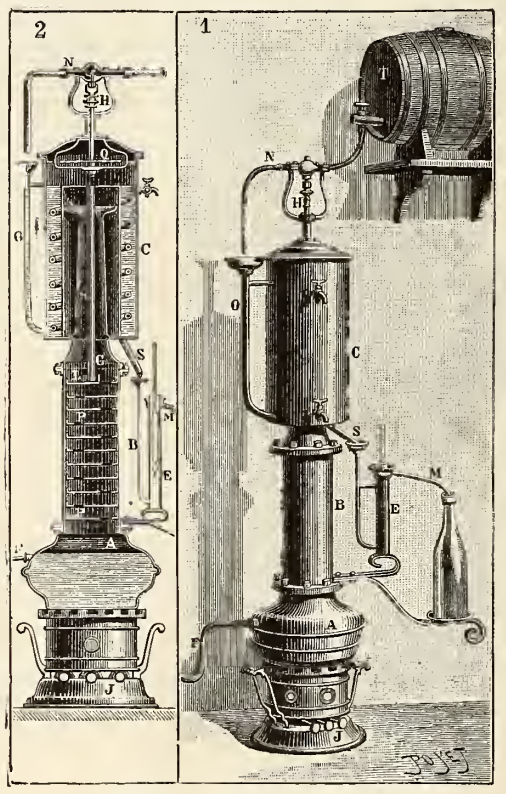
Various estimates have been made of the consumption of borax throughout the world, and one of the methods of ascertaining this is by referring to the productions of different countries and converting the different materials in their equivalent of borax. We thus find the production to be as follows:

| | Tons. |
|---|---|
| Asia Minor | 8,000 |
| Thibet | 2,000 |
| Italy | 3 000 |
| United States | 6,000 |
| Chile and Bolivia | 3,000 |
| Total | 22,000 |

As the American and Asia Minor supply has been developed within the last twenty years, it will be seen that the uses of borax, to the extent of 14,000 tons per annum, have increased during that period, or nearly 300 per cent., and it may be taken for certain that its uses will still further extend.—*Chem. Trade Jour.*

## FAMILY STILL FOR CONTINUOUS DISTILLATION.

THE production of alcohol in France is submitted to very severe fiscal laws, enacted for the twofold purpose of arresting the progress of alcoholism and furnishing the treasury with a portion of its revenue. It has




NEW CONTINUOUS STILL.

been necessary, however, in the presence of certain considerations of various kinds, to make an exception in favor of owners of cultivated land who desire themselves to convert their crops into alcohol, and who are designated as *bouilleurs de cru* (distillers of wines and fruits). Occasion has been had several times to discuss the complete or restricted exceptions that they should have the benefit of, and the question, which is very complex, has not as yet been very completely elucidated. It will doubtless often return to the front. Some, who are partisans of the total exemption from tax, take as their basis the right of which a landowner cannot be deprived of transforming the products of his harvest himself as he prefers to. Others, who are enemies to the privileges granted to these distillers of wine and fruits, assert that it is to open a door too widely to fraud, and they are perhaps not wrong, since alcohol is exempt only so long as it is not delivered to commerce. If the manufacture is no longer controlled, the sale becomes difficult of surveillance. However this may be, exemption has almost always prevailed up to the present, and, although twice (in 1804 and 1873) restrictive laws have been enacted, their application has lasted but a very short time.

We make no pretension to decide, nor even to discuss the question, but shall confine ourselves to an examination of what the means are that are ordinarily employed by the small landowner who manufactures his own cognac, kirsch and fruit brandies, and to making known a new apparatus that we saw at the last agricultural exposition, and that appeared to us very practical.

In most cases, the farmer employs but slightly improved apparatus, either because they belong to him or because he has made application to itinerant distillers who make a business of repairing to the husbandman's place during the winter.

The apparatus consists, as a general thing, of an ordinary still, that permits of distilling upon a water bath in order to prevent an overheating, which would give faints; but the latter may proceed likewise from alcohols of the first and last run, which become mixed, besides, if the operation is not well conducted. So distillation with such apparatus is quite a delicate matter and requires a continual surveillance in order to give good results.

In the large industrial continuous distillation stills special measures have been taken, the principal one of which consists in the use of the arrangement known in laboratories as Wolf's vessels, and that permit of utilizing the phenomenon of the successive ebullition of alcoholic liquids, whose point of vaporization is, as we know, so much the less elevated in proportion as they are richer in alcohol. Greatly improved portable apparatus based upon this same principle have been made for some time past. Mounted upon wheels, they can be easily transported, but they are quite high-priced and are applicable rather to the purposes of those who have a large harvest. For the small farmer, who has but little to distill and does not wish to apply to the industry, Mr. Esteve has endeavored to realize on a small scale the same advantageous arrangements that are found in the industrial apparatus, and has had Mr. Bernard construct a cheap apparatus that permits, despite its small bulk, of distilling a relatively large quantity of liquid, because the operation is continuous.

The regularity of the heating, which is an essential condition for a good distillation, is obtained through a petroleum furnace with multiple wicks, that permit of regulating the flame in a precise manner. Upon this furnace, J (see figure), is placed the apparatus, which consists of a copper, A, surmounted by a column, B, and a worm, C. This latter is not surrounded with water for cooling it; it is the liquid itself that is to be distilled that fulfills this office and that begins from this moment to become heated. This of itself effects a considerable saving in fuel. The liquid may be contained in any sort of reservoir, such as a small cask, T, placed above the apparatus. It falls into a funnel, O, fills in the cylinder, C, the space comprised between the spirals of the worm and then overflows through the tube, G, which debouches in a small cup, L, forming a hermetical joint for the air and vapors, but allowing the liquid to flow continuously over plates, P, arranged in the column, B (Fig. 2). All these plates are flat, without flanges, and contain an aperture. They do not retain the liquid, but serve to divide it before it enters the copper, A. It thus presents a wide surface of evaporation which facilitates the disengagement of the vapors of alcohol, and when it enters the copper it contains scarcely anything but water and last run faints, but whose point of evaporation is more than 100°. They are, therefore, not collected, but make their exit through the waste pipe, F, which keeps the level constant in the copper. The vapors disengaged meet with the plates in ascending and make their way in a direction contrary to that of the liquid, so that the latter condenses the vapors the least charged with alcohol until allowing of the passage only of the richest, which unite with each other in the cone, R, at whose upper part the worm debouches. They entirely condense in the latter and flow in the form of alcohol through the extremity, S, of the worm into a test glass, E, into which dips an alcoholmeter that permits of showing at every instant whether the desired degree is obtained. The test glass is provided with a waste pipe, M, that debouches in the final receptacle.

It will be understood from what precedes that the flow of the liquid into the funnel, O, should be so regulated that it shall circulate slowly enough in the apparatus to permit of the complete exhaustion of the alcoholic vapors, while at the same time keeping the worm at a temperature sufficiently low to obtain a condensation. Such regulating may, through feeling one's way, be obtained by hand in turning the cock of the reservoir more or less, but that would necessitate a surveillance that it has been desired to avoid. So the inventor has arranged an automatic regulator that consists (Fig. 2) of a small receptacle, Q, of thin metal, containing a volatile liquid. This is fixed beneath the cover of the refrigeratory, which supports likewise the valve cock, N, that controls the entrance of the liquid. A rod carrying a nut, H, moves freely between this valve and the receptacle, Q. When the latter expands, in consequence of the elevation of temperature, it thrusts the rod, which opens the valve and allows more of the liquid to flow. A contrary operation takes place if the temperature falls. On regulating the length of the rod by means of the nut, H, in a preliminary experiment, according to the degree that it is desired to obtain, an equilibrium is reached that is preserved during the entire course of the operation and surveillance becomes unnecessary.

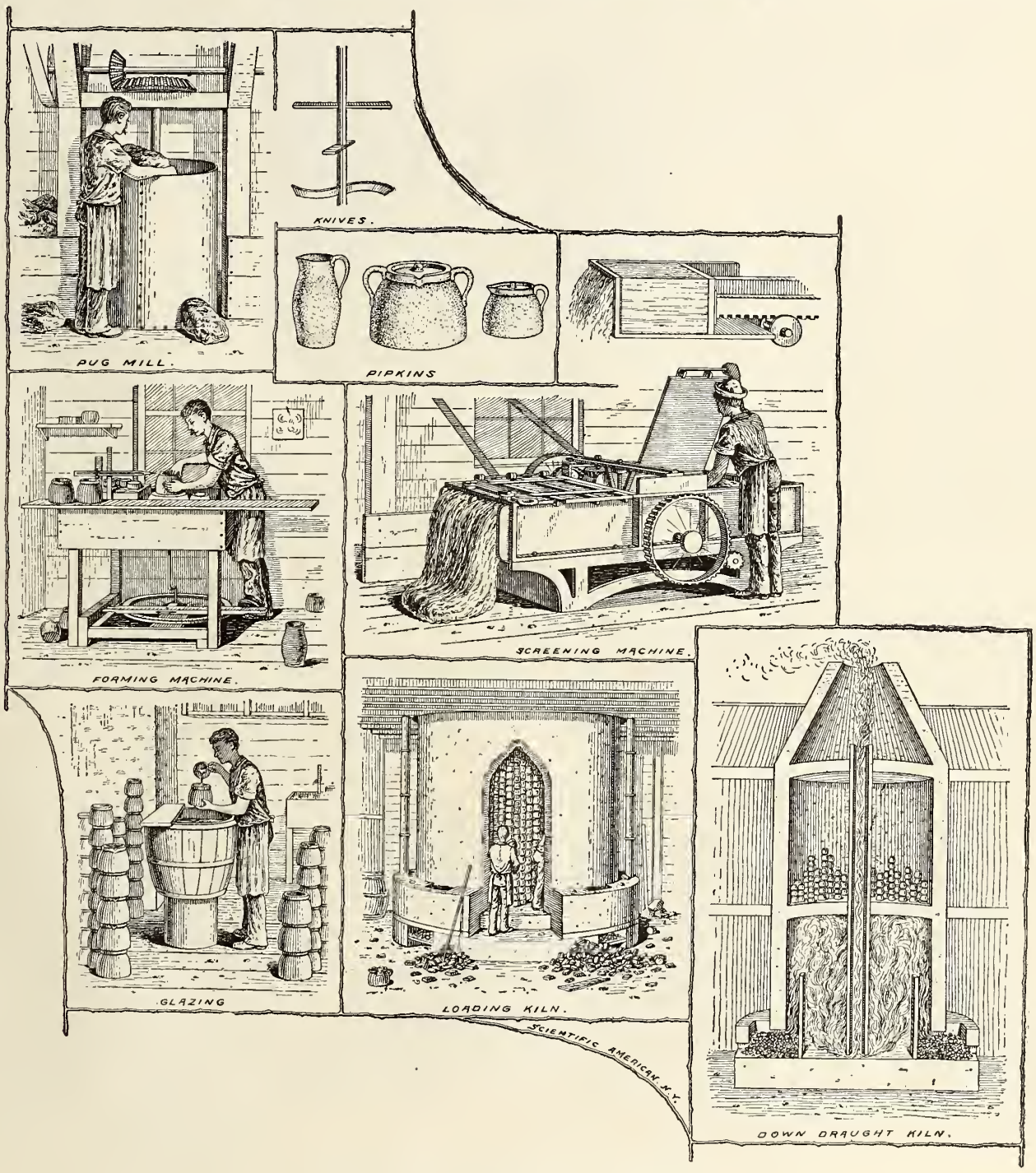
This still has appeared to us a very practical one for the small farmer. It is made in different sizes and the price of it is moderate.—*La Nature.*

## MANUFACTURE OF PIPKINS.

A GREAT quantity of the clay used in the manufacture of pottery and bricks comes from the State of New Jersey. There are large tracts of the material on each side of the Raritan River, between South Amboy and the city of New Brunswick. The clay is slate colored and of different qualities. The beds or pits in some places are 50 ft. or more in depth, and run from one-half to one mile in width and length. Large plants engaged in the manufacture of pottery and brick line the river on each bank. The clay is shipped to the potter in a hard, chunky state, being first moistened with water, and then run through a pug mill and screener before it becomes of the right texture to be worked into pottery. The first operation in the manufacture of pipkins after the moistening the clay is the tempering of the material in the pug mill. This mill is circular in shape and made of wrought iron, about 4½ ft. in height, about 3½ ft. in diameter, and about ½ in. in thickness. An upright shaft with a number of knives attached revolves around in the center of the apparatus at the rate of 75 to 100 revolutions per minute, causing the clay to be worked up in a soft dough. About 600 lb. of the material is placed in the mill at a time, and after being worked up by the knives for about fifteen minutes, it is forced out through an opening at the bottom by the two lower knives, which are shaped so that in making their revolutions they both pass through and force out the material through the opening below. The tempered clay is then taken up and put into the screening machine. About 200 lb.

of clay is put into an iron box at the end of apparatus which is about 3 ft. in length, 2 ft. in width and about 18 in. in height. Across the front end of box is a piece of wire netting, 24 meshes to the inch, through which the material is forced. The clay is pressed through the meshes by means of a movable plate or ram. Connected to the back of the plate are two square iron bars, the under sides of which are slotted. These bars pass over two gearing wheels underneath, which when the machine is in motion forces the ram ahead, which in turn presses the clay through the meshes of the netting. The box or machine empties itself in about two minutes. The material is then taken up and weighed out into 2 and 7 lb. pieces to be formed into pipkins. The next operation is forming. A piece of clay is placed on a circular wooden block about 14 in. in diameter, attached to the under side of which is an upright shaft. This shaft connects itself below to a 3 ft. drive wheel with a treadle attachment. The operator, to make the circular block with the ball of clay revolve, forces the treadle back and forth with one of his feet, causing the block to revolve at any rate of speed. The pipkin is formed entirely by the hands, the attendant pressing into the center of the ball of clay, which by holding the hand in a certain position causes it to grow in height, thickness and in a circular shape, the point of the gauge showing the attendant when the required size is reached. A good operator can form from 18 to 50 pipkins per day, according to size, which run from ½ pint to 1 gallon. After forming they are put into the upper part of a kiln to dry. As soon as they can be handled they are glazed. This requires three operations, the first two being on the inside and the other on the outside. The first process is a white body mixture, consisting of a solution of feldspar, flint, china clay and ball clay. The second process consists of the same ingredients, with the exception of ball clay, with addition of zinc, Paris white, and dry white lead, the materials being mixed up with water and run through a 120 mesh sieve. The pipkin is held in one hand and the solution poured into it with the other. After the inside is thoroughly saturated the solution is poured out and the pipkin put one side to dry, which takes about 4 or 5 hours, the coating drying white. They then pass through the next operation on the outside, which is done by dipping, the attendant spreading his hand out on the inside of the pipkin and pressing it down into a mixture called black lining or Albany slip. An operator can glaze from 1,200 to 1,500 per day. After they can be handled they are placed in the lower part of kiln to burn. The kiln is about 30 ft. in height, 12 ft. in diameter, 2 ft. in thickness at the bottom and made of brick. It is divided into two compartments, the upper one for drying purposes and the lower one for burning. It is called a down draught kiln, having an 18 in. square chimney running up through the center. Each compartment has a convex crown 9 in. in thickness. The lower kiln is about 10 ft. in height and the upper about 8 ft. The lower kiln is fitted up with seven 6 × 18 in. fire bags. After the lower kiln is loaded up with about 1,800 pipkins, the doorway is plastered up and the fires started. The flames from the fire pits rise up through the bags on the inside to the crown above and down to the bottom of the kiln, where they pass through eight holes in the bottom corners of the chimney, passing out at the upper end. After burning for about twenty-four hours at a white heat, the fires are then put out and the kiln allowed to cool. After cooling, the pipkins are taken out and packed for market. The clay is bought by the ton, the price varying from $1.50 to $5 per ton, according to the grade.

Our sketches were made in the establishment of John J. Leonard, West Bergen, N. J.




MANUFACTURE OF PIPKINS.

## SOME RECENT ADVANCES IN PHOTOGRAPHIC CHEMISTRY.*

By CHAPMAN JONES.

PHOTOGRAPHY, as ordinarily practiced, is an empirical art. Although it is founded upon, and intimately connected with, certain branches of chemistry and optics, very few photographers know anything of these sciences. The ordinary practitioner, whether amateur or professional, works entirely by rule of thumb, and is guided by tradition rather than by reason. It is natural, and perhaps necessary, that this should have been so at first, but it must be allowed that the sooner the art is put upon a sure foundation the better, though doubtless there will always remain some who will prefer the old ways.

There is now a larger amount of scientific work being done in connection with photography than heretofore, and I would suggest that the time has come when we should make a determined effort to get rid of uncertain and obscure processes in serious work. When one's only aim is amusement, then, of course, there must remain free liberty to follow any fancy, but for the production of valuable records of any sort, whether pictorial or otherwise, I think the time has come when photographers ought to avail themselves to the fullest extent of all the scientific knowledge at their disposal. Any who are unable to guide themselves should, as is usual in other industries, seek the advice of those who are able to give them assistance.

As an example of the disastrous effects of working in the dark, I may say that I have heard of photographers, both amateur and professional, who have many large and valuable negatives intensified by the mercury and silver cyanide process that have so much changed from their original condition as to cause grave anxiety. It would have been wise, though perhaps hardly possible, if photographers had declined to use this process until it had been properly investigated by a chemist. Then no trouble would have ensued.

We may for convenience sake, with reference to the majority of photographic operations, divide the photographer's work into two parts, namely, the making of the negative and the making of the print. If we accept those cases in which, for scientific purposes, the negative itself is preserved as the record, as, for example, in spectrum work, then the end and aim of the photographer is the preparation of the print, and the negative is nothing more than the tool used in its production. In this sense, therefore, the print is of much more importance than the negative. It should be of a permanent character, while the tool used in the making of it may perfectly serve its purpose, though it were so shortlived as to fade away immediately after it had yielded the print. But it is convenient, and often of great importance from an industrial point of view, that the negative shall be stable. And if the negative is not right, the print must be wrong, and if the negative is produced by uncertain processes, we never can tell what the print will be. The science of negative making becomes therefore, I think, of as much importance as the science of printing processes. As the chemistry of these latter has received enough attention to enable any one to make prints that are perfect from a chemical point of view, while the chemistry of negative making has been very largely neglected, I have spent a good deal of time during the last few years in examining some of the operations in common use, and propose this evening to look at one or two matters in connection with the chemistry of negative making on gelatine plates.

The silver bromide particles held in the gelatine film are so changed by suitable exposure to light that the developer is able to take away the bromine from them. In a chemically perfect negative, after fixing and washing, the image will consist of pure metallic silver, and it does not matter at all where the bromine has gone or what changes it has produced in the developer, so long as no trace of it, or what it leads to, remains behind. But when bromine is added to an alkaline solution of pyrogallic acid, it produces a brown color, and as there

* A recent lecture before the Society of Arts, London. From the *Journal* of the Society.

is most bromine removed where there is most silver deposited, the brown coloring matter will be, roughly speaking, proportional in quantity to the density of the negative, unless some of it is removed. There is, perhaps, no *prima facie* reason why an image of this composite character should be objected to. Indeed, the presence of this brown stuff may improve the negative if the film has too little silver in it to give proper density alone, or if the exposure has been too short to change a sufficient amount of the silver bromide into the developable condition, or if the development has been unduly curtailed. It is easy to see, therefore, that a cheap manufacturer and an incompetent, rule-of-thumb photographer may have definite reason for advocating the use of the stain-producing developers. But to rely upon staining matter in the making of negatives is to lean upon a broken reed. The residues obtained by the partial destruction of some complex organic substances are almost pitchy in character, and seem to be very unalterable by ordinary atmospheric influences. But the staining matter produced by the oxidation of developers, so far as I have yet discovered, is never of this kind. Pyrogallic acid generally yields brown products, inclining sometimes to red and sometimes to yellow; but twice I have obtained solutions of so fine a deep blue color that it might have been mistaken for Prussian blue. These blue colors, on standing for a few hours, faded to a yellowish brown. The deep reddish brown color obtained by simple aerial oxidation of a solution of pyrogallic acid and sodium carbonate becomes perceptibly lighter in a day or two when bottled up, and in a week or so may have lost perhaps half the depth of its color. I think one is quite justified in saying that neither the quantity nor the quality of these staining matters can be controlled, that they are in every way uncertain, and that, therefore, they ought to be rigorously excluded, or perfectly removed, from every negative of value.

And these are far from being all the reasons why the presence of staining matter in negatives should be avoided. A silver image is reliable, and can be chemically worked upon with perfect certainty as may be desired. But staining matter cannot form a foundation for after work, and it will suffer change with almost every operation upon the negative. Its color will change and rechange, and by washing it will, under some circumstances, be partly removed. We know very well that when a part of the image is removed by applications to the surface of the film, the shadows lose a greater proportion of density than the lights, because the dark detail is in the upper or outer surface of the film only, and so is more easily attacked. Therefore, granting for the moment that a negative with an image that consists partly of staining matter has correct gradation, if a part of the staining matter is removed the gradation will be falsified, and this alone would be sufficient reason for condemning the use of staining matter in negative making.

There is another source of staining matter, namely, the oxidation of the developer by its exposure to the air during development. The coloring matters so produced may or may not be the same as those resulting from the action of bromine, but, so far as my experiments go, they behave in a similar manner with reference to those changes that are of practical interest to photographers. The darkened solution will soak into the gelatine and color it more or less uniformly, and it appears that it may perhaps also intensify the image by deposition upon it, if we take into account recently published experiments. Mr. A. W. Dolland* has shown how by the use of glycerine gold may be deposited upon the metal in a platinum print, the platinum apparently remaining quite unaffected, and merely determining by "contact action" the precipitation of the gold from a solution that is ready to deposit it upon the least disturbance. Mr. E. J. Wall† has confirmed the results of earlier workers, who found that silver might be similarly deposited. And coming still more closely to the point under discussion, Dr. R. E. Liesegang‡ has recently observed that substances of the nature of pigments may be deposited upon a metallic basis in an analogous manner. He found that the staining matter produced by the aerial oxidation of pyrogallic acid, hydroquinone, and similar substances in alkaline solution would deposit upon and intensify the image of a silver print. A solution of amidol with carbonate of soda he found would deposit colored oxidation products upon the image of a platinum print. It is, therefore, but natural to suppose that probably sometimes the staining matters produced by aerial oxidation in developers will deposit upon the image in negatives, and add to the oxidation products that are already there, produced by the action of the bromine as before described. I have made one experiment in this direction, by soaking part of a negative in an alkaline solution of pyrogallic acid, allowing it to remain until the solution and the negative were both well colored, and then washing for a short time. The color, of course, retarded printing, but I could not discover any intensification effect. It is possible that the staining matter produced by aerial oxidation may attach itself more readily to the image when the image is freshly formed, or it may be that it does not attach itself to the image at all under the conditions which hold during development.

Every photographer knows how to set to work to avoid the production of staining matter, but I think that very few know how to get rid of it when it is in a negative. The usual method is to apply an acid solution—a so-called "clearing solution." The stain may disappear, and then the photographer imagines that it has gone. The error of this empirical and rule-of-thumb method can be easily demonstrated. If hydrochloric acid, sulphuric acid, sulphurous acid, or alum, is added to an oxidized alkaline solution of pyrogallic acid, the brown color is changed to a lighter brown, and immediately a yellowish insoluble matter begins to fall out of solution, and continues to increase in quantity for some considerable time. In a negative where there is not much stain this change of color may cause it to disappear, and the superficial observer would then think that he had got rid of it, while really he had made it, or a large part of it, more permanent than before by rendering it insoluble. It is easily shown that this precipitated matter generally constitutes a very important part of the staining material, by dissolving it in carbonate of soda and comparing the color so obtained with that of the original or of the part not precipitated. Citric acid differs from the acids mentioned above, in that it gives no precipitate, but citric acid and alum together give a copious precipitate, even when the quantity added is many times more than sufficient to render the solution strongly acid.

It appears, however, to be possible in aggravated cases to get a small residuum of stain from the use of pyrogallic acid, and rather more from the use of hydroquinone, which it is very difficult indeed, if not impossible, to remove. This residual stain I find to be quite unaffected in appearance by any of the usual clearing solutions, unless they contain iron, and then the color is somewhat changed in tint, and if anything a little darkened. It may be remarked, also, that staining matters vary somewhat, and that exceptions may be found to the results that I have described, but I believe that such exceptions, if any exist, will be found so rarely that it will be practically impossible to take cognizance of them in framing rules for general work. Ferrous oxalate has often been recommended as the most perfect developer when stainless negatives are desired, but although ferrous oxalate is a very useful reagent, I cannot confirm the superiority that is claimed for it. Every developer in use will give clean, grayish black negatives, if properly employed, but by making a careful comparison of ferrous oxalate with eikonogen on a plain gelatine film, I find the iron developer to leave a slight color, which is very difficult, if at all possible, to remove, while the eikonogen leaves none. I have no doubt whatever that metol, amidol and rodinal would all show a like, if not a more marked, superiority. It may be observed that in making such comparisons it is necessary to use a simple gelatine film, because the stain left by ferrous oxalate, when it is applied in the same manner as is usual in development, is easily masked; and it should be understood, too, that the difference is slight. Still what difference there is, is in favor of the alkaline developer.

The rules for practical work that I have deduced from my experiments I have followed for some years with uniform success, nor have I ever heard of dissatisfaction from those who have accepted my suggestions in this matter. I believe that the greatest freedom from stains due to the developer is secured by the use of an alkaline developer with sufficient sulphite, and fixing in a solution of hyposulphite to which sodium sulphite and sodum carbonate have been added. A very few minutes washing between development and fixing is sufficient, but the fixing solution should not be used after it gets dirty or discolored. After thorough fixing should follow a thorough washing, and with a well coated plate this will be a matter of two or three hours or more. By this method any staining matter is kept in its most conspicuous form, and in its soluble, and therefore most readily removable, condition; and it must surely be allowed that this is the right principle to work upon. Alum should never be used until the washing is finished, because it retards the washing; so-called "clearing solutions" should not be used, both because they tend to make the stain less obvious, and they make its removal impossible; acid fixing baths should be avoided for the same reasons, and if they harden the film, their use is still more detrimental, because in doing so they render the washing more tedious or less perfect.

Having obtained a pure silver image, it may be found that its density is not suitable. It is well that the density should never be too great, because there is no practically useful method of reducing it that does not alter the gradation. On the other hand, intensification is certain and easy, and does not falsify the gradation, when done in a suitable manner. In papers read before the Photographic Society and the Society of Chemical Industry, I have detailed the chemistry of mercurial intensification, and shown that ferrous oxalate is the only reagent that can be relied upon to follow mercuric chloride. Potassium silver cyanide is not suitable, because the image it gives is not of constant composition, and is not permanent; ammonia is unreliable, because it gives images of complex and varying composition, which cannot reasonably be expected to be permanent; all simple alkalies are out of the question; sodium sulphite gives a pure metallic image, but in smaller quantity than the original image, and often, therefore, gives no intensification effect; sodium hyposulphite also gives an image containing a less weight of metal than the original, and, besides, is likely to give very complicated unstable images if used sparingly. Ferrous oxalate, on the other hand, is a perfect reagent, leaving every atom of silver in the original image with an atom of mercury added to it.

The most excellent point of this method of intensification is that, so far as I can discover, there is absolutely no loss of even the faintest detail, but a perfect and proportional action throughout. But this very excellence has proved a drawback in the hands of dirty workers, and workers with unclean plates. A silver stain will be intensified as well as the silver image, and must be so if the action is perfect. I know of no failure by this method not due to imperfect washing or other faulty work. But some photographers say they have found alkaline developers, or alkaline developers without the alkali (if the expression will pass), better than ferrous oxalate, and they have recommended these reagents, I am sorry to say, without a knowledge of their action. If they work as they are stated to do, "cleaner" than ferrous oxalate, that is a pretty sure indication that they are less perfect, unless the only difference is due to the precipitation of the lime in the water when oxalate is used. I have tried many of these solutions, and none of them are reliable. By the use of them, mercury that ought to be in the image is lost, and one cannot tell how much mercury will be so lost, nor from what part of the image it will come. It is hardly conceivable that the mercury lost can come proportionately from every part of the image, and if the loss is not proportional throughout, the density gradation of the negative is upset.

Sodium sulphite, when applied alone, removes both silver and mercury from the bleached image, but with a developing agent, whether with or without alkali, I have never found any silver in the solution.

Eikonogen alone I found to act very slightly. With sulphite a great deal of mercury was lost. Eikonogen 12 grains, sodium carbonate 25 grains, and sodium sulphite 25 grains, to water 1 ounce, acted well, but 19 per cent. of the mercury was lost. Metol alone gave no perceptible action. Metol 2 grains, sodium sulphite 4 grains, to 1 ounce, acted well, but very much mercury was lost. Metol 4 grains, sulphite and carbonate 24 grains each, to 1 ounce, acted well, but 32 per cent. of the mercury was lost. Amidol 2 grains and sulphite 20 grains to the ounce worked well, and 10 per cent. of mercury was lost. This appeared hopeful, so I tried amidol 8 and sulphite 20, but this was useless, as its effect was very slight indeed within a reasonable time. So I diminished the amidol instead of increasing it, and tried amidol 1 and sulphite 20. This worked well, but 42 per cent. of the mercury was lost. On mixing the amidol and sulphite, sulphurous acid is set free. By adding ammonia to the mixture a blue color appears when the alkali is in a little excess, and by adding ammonia in quantity, just insufficient to produce this color, a solution may be prepared that will remain slightly alkaline throughout the reaction. Such a solution acts very energetically, but a very large quantity of mercury was dissolved by it. Pyrogallic acid 3 grains, sodium sulphite 8 grains, ammonia 3 minims to the ounce, gave a loss of 29 per cent. of the mercury, and the solution was much more colored than in any other case. Pyrogallic acid with sulphite slightly acidified was no better.

In some cases, as stated above, I have estimated the actual proportion of mercury in the solution, and therefore lost from the image, but these numbers must be taken as only giving a general idea of the amount. In some cases, by prolonging the action a little it would have been increased, and probably in no case would the same loss occur by repeating the experiment.

Thus I am obliged to come to the same conclusion now that I did when I first drew attention to the chemistry of mercurial intensification, namely, that ferrous oxalate is the only satisfactory reagent to follow the application of mercuric chloride. I show an example in which this method of intensification has been carried out on various parts of the same negative, once, twice, three times, and four times, without a suggestion of stain or trouble of any sort. It should be noted that this repeated application of the process is a very severe test of its cleanness when properly carried out. If there had been the slightest false deposit of mercury at any stage, this would have been doubled by the next treatment, and increased to four times and to eight times by successive treatments. Silver would have increased similarly, but to a still greater degree. I could show many negatives intensified by this process, but they are similar in appearance to unintensified negatives and therefore would not be instructive.

There is only one other matter that I will refer to at present, and that but briefly, namely, the getting rid of the hyposulphite from the negative. Experience appears to indicate that if a negative is of a satisfactory density, the small amount of hyposulphite left in it after from two to four hours washing does no harm. But if the negative is to be intensified, any hyposulphite will cause a precipitate of mercury salt, and so give a false deposit. This would, as a rule, matter but little, but for the fact that a gelatine negative is always difficult to wash evenly, and such a false deposit will, therefore, almost always occur in patches. If the gelatine film is of exactly the same thickness throughout, equal washing all over is difficult, but in most plates there are variations in the thickness of the film that make it impossible, unless it is so prolonged as to be practically perfect in the thickest parts. What we want is a reagent that will oxidize the small residue of hyposulphite into sulphate, which is quite inert, without affecting the image or attacking the gelatine. I do not know of any reagent that will do this. Peroxide of hydrogen, as described, appears to be excellent, the general idea being that it produces sodium sulphate and sulphuric acid from the remaining hyposulphite, but this is a mistake. It produces no acid, and only about one-third of the sulphur is oxidized to sulphate. By mixing sodium hyposulphite with a large excess of the peroxide, and allowing them to remain together for three days, less than half the sulphur was changed to sulphate, and whatever change had been produced it was of little, if any, use, for the solution still gave a precipitate with mercuric chloride. Peroxide of hydrogen appears, therefore, to be of no avail; but, even if it were, it would be a very unsafe reagent in the hands of ordinary photographers, because its strength is very liable to decline. It may in a few months be only one-tenth of its original strength, and a bottle freshly opened, though originally without doubt of full strength, may be found to contain only a third of the stated quantity; and these changes lead to no alteration in the appearance of the liquid, and can only be recognized by a direct test. These uncertainties render it of very little use in the hands of those who are unable to estimate its strength. Alum and acids decompose sodium hyposulphite, but a mixture of alum and hydrochloric acid acts very slowly upon a weak solution of it, so slowly that one might be tempted to say that it also was useless. I find, however, that a fairly well washed negative is made more fit for intensification by treating it with an acid solution, or an acidified alum solution, and washing again, and I fancy that the improvement is not due merely to the extra washing that it gets. Whatever may be the actual change brought about by this treatment, I find that it is advantageous from a practical point of view, and that it is a desirable precaution to take.

* *Journal of the Photographic Society*, N. S., xviii., 189

† *Journal of the Photographic Society*, N. S., xviii., 184.

‡ *Photographic Work*, iii., 121.

## THE BERLINER PATENT.

THE Harrison International Telephone Company recently obtained opinions from several eminent firms of patent lawyers in regard to the validity of the Harrison and Ford telephone patents, all of the opinions declaring that there is no infringement of the Berliner patent. The opinion of Messrs. Witter & Kenyon is particularly interesting on account of its analysis of the status of the Berliner patent, which is as follows:

"The Berliner patent only covers the use of electrodes that are in constant contact and that operate by variations of the pressure of contact. Your tele-

phone operates by a making and breaking of contact; its electrodes are not in constant contact. The Berliner, like the Bell telephone, throws upon the line wire an undulatory current. Your telephone throws upon the line wire a pulsatory current. Such a pulsatory current was not covered by the Bell telephone patent of 1876, and the United States Supreme Court so decided in the telephone cases. The Berliner patent is no broader in this regard than the Bell patent was. The method of operation of your telephone is thus substantially different from that of the Bell and Berliner telephones. This fundamental difference was, as we understand it, the ground on which the United States Circuit Court in Arkansas refused a preliminary injunction against your company several years ago under the Bell patent, although the injunction was asked for after the United States Supreme Court had sustained that patent. We quote here the two broadest claims of the Berliner patent to show its meaning and scope.

"'1. The method of producing in a circuit electrical undulations similar in form to sound waves by causing the sound waves to vary the pressure between electrodes in constant contact, so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

"'2. An electric speaking telephone transmitter, operated by sound waves and consisting of a plate sensitive to said sound waves, electrodes in constant contact with each other, and forming part of a circuit, which includes a battery or other source of electric energy, and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate.'

"This view of the meaning of the Berliner patent is confirmed by the proceedings in the Patent Office during the fourteen years while this application was pending, which proceedings we have examined; and in our judgment, under all the circumstances of the case, this Berliner patent will be construed by the courts as narrowly and strictly against the Bell Telephone Company and in favor of the public as is possible.

"Again, we are of opinion that the Berliner patent is in any event wholly invalid and void, and will be so declared by the United States courts, either in the pending government suit or in the first suit for infringement that the American Bell Telephone Company may see fit to bring. The same invention was patented to Berliner in an earlier patent, and no one can have two patents for the same invention. The claims of that earlier patent are narrow and do not cover your telephone, but under recent decisions the later patent is wholly invalid.

"Again, the Berliner application, while pending in the Patent Office, was unlawfully and illegally amended in such a way as to strike out from it the real invention which had formed the subject matter of the original application and to interpolate new matter and a new and different invention in fraud of other applicants and of the public - a thing which cannot lawfully be done and which cannot form the basis of a valid patent.

"Again, before the real invention which is now patented in the Berliner patent appeared, even by way of amendment, in the Berliner application, it had been in public use and on sale in the United States for more than two years—a fact which would have constituted a statutory bar to the filing of a proper and lawful application at that time and which now equally invalidates the patent, for the law does not permit the obtaining by indirection of what it bars if openly and properly sought.

"Again, the application was abandoned and forfeited prior to the issue of the patent."

## CAUDERAY'S ELECTRIC CLOCK.

NUMEROUS inventors have occupied themselves with the application of the electric current to clockwork. The thing is seductive, in fact, since by this means, while simplifying the mechanism, we dispense with winding, the immediate result of which should be the lowering of the price of the apparatus and the facilitating of the use of it. Yet, up to the present, we have not seen many electric clocks. Aside from their use in a few cities in which an electric distribution of time is made by a central station, independent clocks for private use are not very widely employed. This is probably due to the fact that, in spite of appearances, the systems proposed have hitherto been of too delicate operation or of too high a price; for at present, when there are few houses that are not provided with electric bells and consequently with a battery, there is no reason why the current should not be utilized for operating a chamber clock.

This is doubtless what was thought by Mr. A. J. Cauderay, who has just constructed a very simple and very plain electric clockwork movement capable of operating in any position, and the selling price of which will not exceed a dollar when it comes to be manufactured right along.

The system is based upon the principle that in order to make a pendulum swing for an indefinite time it suffices, not to give it a new impulsion after each oscillation, but only at more or less spaced intervals of time. This permits of the use of the battery and electromagnet for keeping up the motion for a very long time without exhaustion of the battery, since the latter furnishes energy only from time to time. It is merely a question of finding the proper moment in which the effect is to be produced.

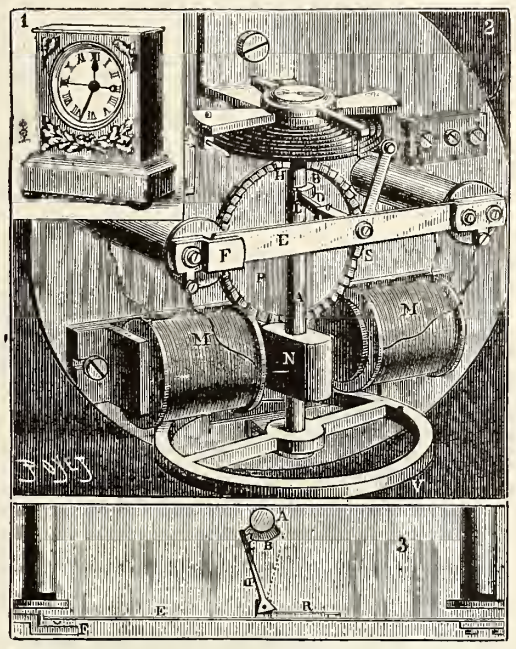
The application of this principle is not new, for Mr. Hipp, of Neuchatel, has for more than twenty years been constructing electric clocks having as a regulator a pendulum kept in motion under such conditions. Upon the same principle also is constructed Mr. Lemoine's "Papillone," and still others.

Mr. Cauderay in nowise lays claim to this idea, but what he has patented is his special application to the spiral balance wheel, which permits of the operation in any position whatever.

The spiral balance wheel, V (Fig. 2), is here at the same time the regulator and the motor. The axis, A, carries at H a detent that acts upon a ratchet wheel, P S, and causes it to move forward by one tooth at each complete oscillation. It is this wheel that carries the seconds hand and that actuates the minute and hour hands through gear wheels.

The motion of the balance wheel is kept up by two electros, M, which attract a small mass of soft iron, N, fixed upon the axis, A. Such action takes place only at the moment in which the oscillations fall beneath their normal value. This result is obtained by means of an ingenious arrangement which is the characteristic of the invention.

The contact that permits the current to pass into the electrodes is located at F, at the end of a flat spring, E (Figs. 2 and 3). In normal time E is distant from F, and the circuit is broken. Upon the spring, E, is fixed a small lever, D, pivoting at one of its extremities and that a small spring, R (Fig. 3), tends to hold at right angles with E. Under the action of the piece, C B, which is fixed to the axis of the balance wheel and follows the oscillations thereof, this lever takes alternately




CAUDERAY'S ELECTRIC CLOCK.

1. General view of the clock. 2. Motive mechanism. 3. Details of the interrupter.

two opposite positions, either that shown in the figure or that shown by dotted lines—but this only on the essential condition that the piece, C B, has a travel sufficient to allow the lever to pass beyond its extremities. If, on the contrary, a half oscillation is too short to allow such condition to be fulfilled, the lever cannot reverse itself, and, at the following oscillation, its extremity will engage with the notch, C. There will then occur a wedging that has the effect of raising the spring, E, when a contact will take place at F, and the action of the electro will permit the oscillation to resume its sway.

It will be seen also from this that if the circuit were broken at any place whatever, the stoppage would always be produced upon the contact, and that, consequently, the motion would be resumed as soon as the circuit was re-established; in other words, the apparatus sets itself in motion without the necessity of a preliminary impulsion by hand.

This has its importance, and shows that Mr. Cauderay's system is capable of serving as a counter of time for determining the duration of any consumption whatever. If it is a question, for example, of an installation of lighting in which the number of lamps lighted is always the same, the discharge being constant, it will suffice, in order to have the output, to know the duration of the lighting.

Such a result will be obtained by branching the apparatus in derivation upon the general line of wires. In this case it is clear that one will have made arrangements for actuating a totalizer instead of a dial train. Such application can be extended in all analogous cases of a constant discharge, electric or otherwise, since it suffices simply to close a circuit at the moment at which the consumption begins.

Up to the present, Mr. Cauderay has applied his system only to a clock (Fig. 1) which contains in its base two dry batteries of a model widely used in England, and that permit of the operation for several months.

If one has at his disposal another source of electricity, as, for example, that of call bells, it can be utilized instead of having recourse to special batteries. This permits of never having to occupy one's self with the clock.

In the movement that we have had in hand, the oscillations of the pendulum kept up for ten seconds, after which the electric action intervened to give a new impulsion. A small lever acting upon the spiral permits, as in watches, of regulating the regular motion of the hands. It would be possible, however, for a clock of precision to have a compensating balance wheel.

Upon the whole, the system devised by Mr. Cauderay is of simple construction and reasonable in price and is capable of receiving numerous applications. As now applied to clockwork, it constitutes a very interesting application of domestic electricity.—*La Nature.*

## WIRE-NETTING MACHINE.

WE illustrate from *Engineering* a neatly designed wire-netting machine made by Wilmott Brothers & Cobon, London, S.E. In machines of this type two sets of wires are used, and the net is produced by the intertwisting of these sets with each other. One set of the wires is coiled up very closely and packed in a series of vertical tubes which are clearly shown in Fig. 1. From the top of these tubes the wires pass out to a roller on which the finished net is coiled. The other set of wires is carried on bobbins fixed at the bottom of the machine. From these bobbins the wires are led up parallel to the aforesaid tubes, and pass through hollow spindles, on a level with and opposite to the tops of the tubes, to the roller already mentioned. Considering one wire of one set and one of the other, it will be seen that by making the tubes rotate round the wires from the bobbins, the wires of one set will be twisted round those of the other. This having been done, the hollow spindles are shifted laterally so that each comes opposite the tube immediately adjoining the one it was previously opposite. If the tubes are each again caused to rotate round the wire now opposite to it, the two sets of wires will again be intertwisted, thus forming half a mesh, which is completed by shifting back the bobbins to their previous position, and again causing the tubes to rotate round the wires. To effect this rotation the top of each tube has half a pinion keyed to it, while the hollow spindles are similarly fitted. When a spindle is opposite a tube the two half pinions form a complete one, which by means of a rack moved horizontally by the crank shown in Fig. 1 is caused to rotate. Thus the hollow spindle and the tube move round each other, twisting together their respective wires as already explained. One twist

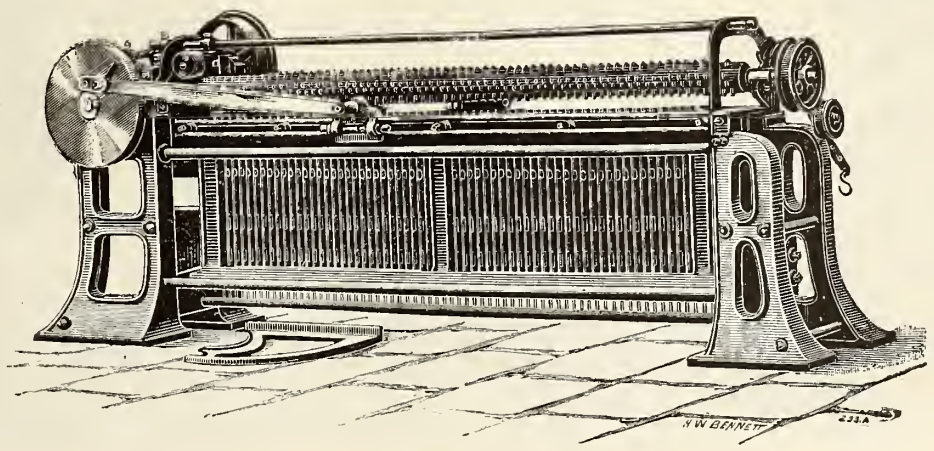


FIG. 1.

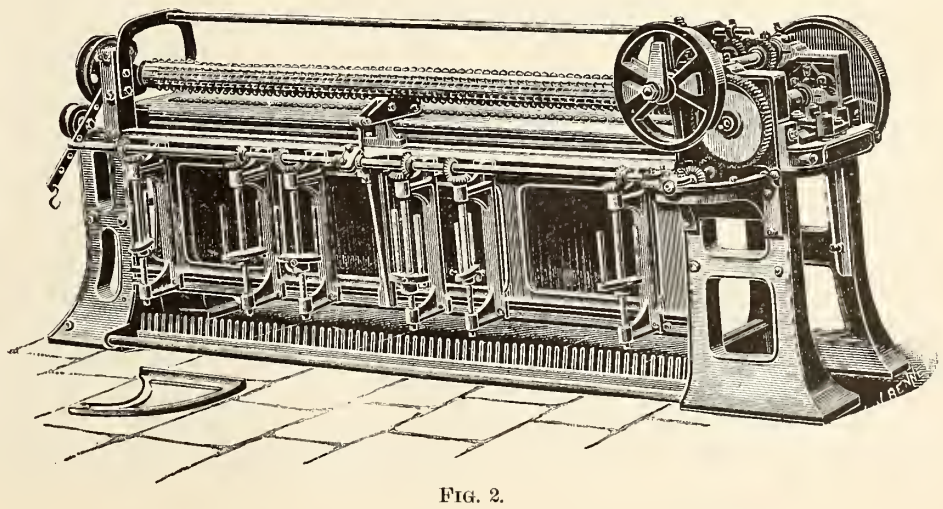


FIG. 2.

MACHINE FOR MAKING WIRE NETTING.

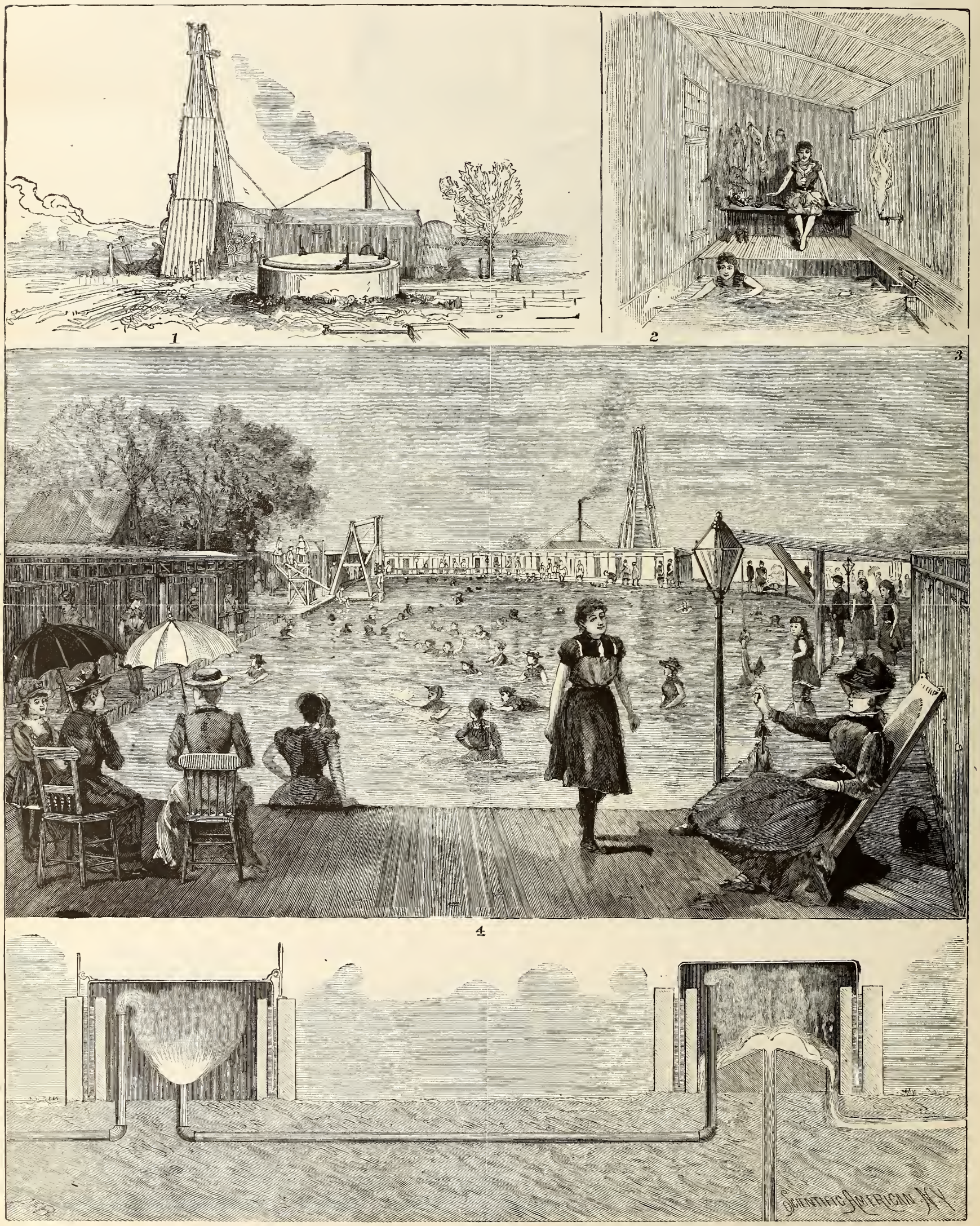
having been completed, the spindles are shifted laterally by a cam motion, so that the half pinion is now fellow to that on the adjoining tube, under which conditions the completed pinions are again rotated by the rack as already explained. The pinions in question can be seen in Fig. 2, which is a back view of the machine. Our description of this machine is based upon that of Mr. J. Bucknall Smith, C.E., in his work on "Wire; its Manufacture and Uses."

## THE STOCKTON WARM WATER BATHS.

THERE are scattered over this country a large number of natural mineral springs whose waters vary, both as to temperature and constituents, to such an extent as to adapt them as curatives to almost every disease human flesh is heir to, and it is a curious fact that we find in the United States springs that correspond in almost every particular to the noted springs in Europe. We also have many artesian wells yielding mineral waters differing widely in chemical composition and varying in temperature from 47° to 184°. Some of these wells were bored with the expectation of finding mineral waters, but the most of them were put down for the purpose of obtaining pure water, petroleum or gas.

At Stockton, Cal., there is an artesian well 1,700 feet deep, from which flow 2,250 gallons of water a minute. In addition to this large flow of water, the well yields 75,000 feet of illuminating gas daily. The well was bored for natural gas, but the water, on account of its pleasant temperature and medicinal properties, was found to have great value for the purposes to which it is applied.

The water issues from the well at a temperature of 86° F., and supplies a miniature lake varying in depth from a few inches to 10 feet. This lake, which is about 400 feet long and 80 feet wide, is fitted up as an immense swimming bath and is surrounded by 115 dressing rooms. The water being continually renewed by the flow from the well, the temperature of the lake is maintained between 80° and 86°. Bathers at this




1. New well and gasometer. 2. Covered baths. 3. The lake. 4. Separating tank and gasometer.

STOCKTON, CAL.—WARM WATER WELLS AND NATURAL GAS.

place derive great benefit from baths in this water, and draughts of it prove beneficial. Analysis shows it to be impregnated with common salt, soda, magnesia, iron, and sulphur. Fish are often seen jumping from the surface of the lake. Several varieties have been caught there by our own artist, who made the accompanying sketches. It is supposed that the fish find their way into the water of the lake through the overflow.

Our engraving shows the separator by means of which the water flowing from the well is separated from the gas and directed to the lake. The gas is conveyed to a gasometer, from which it is distributed for lighting and heating purposes. A second well is being drilled, but up to the present time the only yield from this well is gas. It is thought that the absence of water is owing to its proximity to the first well. However, the work is being pushed still further, with the expectation of finally striking a good flow of water.

When the out of door temperature is too low to permit of bathing in comfort, bathers resort to the covered baths, the air of which is heated by a jet of natural gas burning freely in the room, as shown in one of the engravings.

It is stated that as many as 1,000 bathers can be accommodated daily at this place. In addition to the large bath and the inclosed baths, there are twelve private bath rooms containing large tubs, and other rooms containing bath tubs for children too small to be taken into the lake.

This place has become a great resort not only of the citizens of Stockton and the surrounding country, but of people from distant places who visit the place as much for pleasure as for the beneficial effects of the mineral water. These baths are probably the most popular inland resort on the Pacific coast.

## THE ADULTERATION OF FOOD.*

By H. W. WILEY, Chemist of the United States Department of Agriculture.

BARNUM made a colossal fortune by acting on the principle that Americans like to be humbugged. There is something soothingly seductive in being led to the circus by lurid posters showing unattainable attitudes of impossible monsters. This attractiveness is increased by the knowledge that, like the limited express, it implies an extra charge. The public would rise with unanimous execration were it to attend a circus where side shows were not known and the *post ludum* concerts were free. Were the feats of legerdemain of the mystic Hermann actual performances of supernatural powers, they would lose for us half their charm. To be cheated, fooled, bamboozled, cajoled, deceived, pettifogged, demagogued, hypnotized, manicured and chiropodized are privileges dear to us all. Woe be to that paternalism in government which shall attempt to deprive us of these inalienable rights. There is no point on which the average American is more sensitive in respect of legal restriction than in those instances in which law interposes to prevent him from making a fool of himself. Only after a long struggle has a distinguished citizen of your city, now in public life, been able to prevent the mails from paying the expenses of the delta of the Mississippi. Only the other day, in New Orleans, I read in the lottery advertisement that the ticket drawing the last capital prize of $75,000 had been sold in Washington, Philadelphia and Kalamazoo. This all doubtless comes from the fact that in this country each one of us is just as good as the next, a condition of affairs which, in true Gilbertian humor, has been touched off in the distich :

"When everybody's somebody,
Nobody's anybody ;"

therefore, we should not be surprised at the pertinent inquiry of why A, being no better than B, should interfere with B when B wants to get drunk or buy a lottery ticket.

In regard to the character of what we eat and drink, we find the same unwillingness to be watched over and protected.

A few days ago in Chicago I went out to the Union Stock Yards to look at the process of meat inspection. From each carcass of pork intended for exportation is taken a sample of the flesh and this is carefully examined for trichinæ. "Do you often find diseased samples ?" I asked. "Yes," said the attendant; "from one to two per cent. of all the samples examined is found infected." "Could I see a sample of that kind ?" "Certainly. Has any one a trichinosed sample in the microscope ?" A pretty girl microscopist held up her hand. I looked and saw for myself the curled and coiled serpent ready for a strike. How I congratulated that lucky sarcophagous Teutou who had been saved from a horrid death by the fairy fingers and sure blue eyes of the trichinæ girl. "What do they do with these infected carcasses ?" A shrug of the shoulders led me to believe that they were sent to soap factories, as they doubtless are, and this was followed by the expression, "But Americans don't eat raw pork," and I am led to suppose from this that trichinæ are really very good and nice when well broiled. Next morning, when I ordered ham for breakfast, I asked the waiter to have it cut thin and broiled crisp. Even then when it was brought in I could not help thinking that it looked like a bretzel.

That distinguished jurisconsult and patriot, Senator Paddock, of Nebraska, during the first session of the present Congress, after years of futile struggle, succeeded in having the Senate pass what is known as the Pure Food bill, but it seems from the provisions of this bill that the Congress of the United States has only power to protect the foreigner, the disfranchised and the Indian not taxed. The provisions of the bill are confined to the Territories and the District of Columbia and to interstate commerce. Mild as are the penalties of the bill, allowing the citizens of any State to make a dessert and call it peas if they like, yet it has been left unpassed in the House of Representatives.

The Paddock Pure Food bill, to summarize it briefly, has for its purpose the protection of commerce in food products and drugs between the several States, the District of Columbia, the Territories of the United States and foreign countries, and the Secretary of Agriculture is authorized to make the necessary rules for carrying out the objects of the bill. He is authorized to cause to be punished, through the proper courts, any one introducing in any State or Territory or the District of Columbia or from any foreign country any article of food or drugs which is adulterated or misbranded. The act says that the term "food" shall include all articles used for food or drink by man, whether simple, mixed or compound. In the case of food or drink, an article shall be deemed to be adulterated if any substance or substances has or have been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength, so that such product when offered for sale shall be calculated to deceive the purchaser; further, if it contain any inferior substance or substances substituted wholly or in part for the article, or if any valuable constituent of the article have been wholly or in part abstracted, or if it be an imitation of and sold under the specific name of another article, or if it be mixed, colored, powdered or stained in a manner whereby any imperfection therein shall be concealed, or if it contain any added poisonous ingredient or any ingredient which may render such article injurious to the health of the person consuming it. Further, the food is declared to be adulterated if it consist of the whole or any part of a diseased, filthy, decomposed or putrid animal or vegetable substance or any portion of an animal unfit for food, provided that an article of food shall not be considered adulterated if it be a mixture or compound sold under its own distinctive name, or an article labeled, branded or tagged so as to plainly indicate that it is a mixture, compound, combination or blend.

It will be seen by the above provisions that the bill is very far reaching in its character, and it contains also the proper penalty for enforcing its operation. This bill passed the United States Senate on March 9, 1892. Mr. Paddock, in concluding his speech in advocacy of the bill, used the following words :

"In the name and in the interest of public morality, I appeal to you to set legislative bounds, beyond which the wicked may not go with impunity in this corrupt and corrupting work. Let us at least attempt to perform our part in the general effort to elevate the standard of commercial honesty which has been so disgracefully lowered by these deceptions, frauds and robberies, the malign influence of which is everywhere present, everywhere felt.

"Let us help by our action here to protect and sustain in his honorable vocation the honest producer, manufacturer, merchant and trader, whose business is constantly menaced and often ruined by these unscrupulous competitors, who by their vile and dishonest arts, manipulations and misbrandings are able to make the bad and impure appear to be the pure and the genuine; thus, by a double deception, both as to quality and price, making the worse appear the better choice to the unintelligent mass of purchasers.

"In the interest of the great consuming public, particularly the poor, I beg of you to make an honest, earnest effort to enact this law. At best a great multitude of our people are oppressed by a fear, a never absent apprehension, which they carry to their work by day, and to their beds by night, that perhaps at the end of the following day, or week, or month, their ends may fail to meet. Under the strain of this grim menace life itself becomes a burden almost too grievous to be borne. But the thought of helpless wife and children, whose sole dependence he is, renews the courage of the wage worker from day to day, and so he struggles on, praying and hoping to the end.

"These, Mr. President, are the men, and these the women and children, for whom, before all others, I make this appeal. If you could save to these the possible one-third of the nutritious element of their food supplies which is extracted to be replaced by that which is only bulk, only the form and semblance of that of which they are robbed by the dishonest manipulator and trader, you would go a long way toward solving the great problem of the laboring masses—whether for them it is "better to live or not to live," whether it is better to bear the ills they have, rather than fly to others that they know not of, that lie beyond in the realm of governmental and social upheaval and chaos.

"There is a good deal in the way of comic 'asides' as the momentous social drama which holds the boards at this time, and whose *dramatis personæ* are the so-called common people, rapidly advances to the epilogue. Be not deceived ! the storm doth not abate. It is ever rising. Its violence is ever increasing. Take heed when the people demand bread that you continue not to give them a stone, lest the angry waves of popular discontent may some time, perhaps in the near future, rise so high as to overwhelm and engulf forever all that we most greatly value—our free institutions, and all the glories and hopes of our great republic—which are not ours alone, but which belong—and, if they are preserved and shall permanently endure, will be an ever continuing blessing—to all mankind."

This pure food bill has received the unanimous support of nearly every agricultural organization in the United States. It has been opposed by a number of manufacturing establishments interested in the production of drugs and mixed foods, and also by those largely interested in the manufacture of substitutes for lard. If adopted, it can at once be seen that it would do away with the necessity of the oleomargarine law, which is a special form of legislation and, like all special legislation, must be open to many objections.

As before stated, the national law, as indicated above, does not protect the citizen of any State against an adulterated food which is manufactured and sold within the State. Such police power must be left wholly to the several States. Many of the States already have laws on their statute books dealing with the subject of food adulteration. These laws, however, are for the most part inoperative, and, not being based on a common plan, would naturally not secure, even when fully enforced, the same degree of protection in all States. What is needed for a complete legal protection of the people against adulterated foods is not only the enactment of the Paddock pure food bill, but a similar enactment of a similar scope and aim for each of the several States.

Among the various States which have laws on the subject may be mentioned Illinois, which has an act to prevent and punish the adulteration of articles of food, drink, and medicine, and the sale thereof when adulterated. There is also a special law preventing the adulteration of butter and cheese.

Iowa has a statute, entitled an act to prevent deception in the manufacture and sale of imitation butter and cheese. One of the provisions of this law is that no keeper of a hotel, boarding house, restaurant or other public place of entertainment shall knowingly place before any patron, for use as food, any imitation butter or imitation cheese unless the same be accompanied by a placard containing the name in English of such article printed in plain Roman type. Iowa also has a special law in regard to the adulteration of milk.

Maine has a food law to prevent the manufacture and sale of adulterated lard. Maine also has a general law on the adulteration of food and drinks.

Maryland has a statute to provide for the prevention of the adulteration of articles of food and drink and the sale thereof when adulterated or unwholesome. The enforcement of this law is placed largely in the hands of the State Board of Health.

Perhaps the best of the State laws concerning adulteration are those of Massachusetts, the statutes of which provide that "no person shall, within this commonwealth, manufacture for sale, offer for sale, or sell, any drug or article of food which is adulterated within the meaning of this law." The law of Massachusetts is, in all essential particulars, that of the Paddock Pure Food Bill, of course with such variations as are necessary in the enactment of a State law as compared with a federal law. The law of Massachusetts is especially effective as regards the sale of adulterated milk and other adulterated food and has a system of State inspection which has already reduced the percentage of adulteration of such articles to a very low figure. Monthly returns are made by the inspectors and analysts of foods and drugs. The report for the month of October, which is the latest one, contains the results of the inspection of milk, butter, cheese, olive oil, vinegar, spices, cream of tartar, molasses, maple sugar, maple sirup, honey, tea, coffee, confectionery and miscellaneous articles and drugs. The total number of samples examined was 610 ; the number found to conform to the legal standard was 428, and the number of samples varying from the legal standard, that is, adulterated within the meaning of the act, 182. The percentage of the adulteration was 29·8. The actual percentage of adulteration is very much less than this, for it is only suspicious articles of food to which the attention of the board is directed. Certain staple products, such as sugar, flour, and the various cereal products, are very rarely adulterated and receive but little inspection. The work of the board is, therefore, mainly devoted to the inspection of such articles as have been found, by several years of experience, to be especially liable to adulteration. Eleven actions were brought in the courts during the month for violation of the food and drugs act. Five were for the violation of the statute relating to the sale of milk; two of coffee ; one each of honey, cream of tartar, cloves and pepper. In all of the eleven cases conviction followed and fines of $247 in all were imposed. The cities and towns from which samples of food were collected during the month were Boston, Worcester, Lowell, Cambridge, Springfield, Lawrence, Somerville, Salem, Chelsea, Malden, Newton, Taunton, Waltham, Pittsfield, Brookline, Charlton, Greenfield, Hyde Park, Lee, Marblehead, Milton, Natick, North Adams, Orange, Stoneham, Stoughton and Ware.

The case of Massachusetts is given somewhat at length on account of the excellence of the system of inspection. It shows what a State law can accomplish when wisely made and honestly enforced. In the one item of milk alone, it would be difficult to estimate the amount which has been saved to consumers by the strict enforcement of the law which requires the milk sold to contain a certain amount of total solids and fat.

Time remains only to mention the other States which have laws of some kind on the subject of adulteration. These States are Michigan, Minnesota (which has a series of good laws, both special and general), New Hampshire, New Jersey (which also has a good system of laws), New York, Ohio (also with a fairly good system) and Pennsylvania, which divides its law into three sections; the first relating to liquors, I suppose because this is the most important of the foods of this State ; the second to food adulteration in general, and the third especially to dairy products. The weakness of the Pennsylvania law is not so much in the character of the provisions relating to the sale of foods as in the method of securing their enforcement. It does not provide for any system of inspection as does the law of Massachusetts; and no law relating to the adulteration of food is of any value whatever as a protection to the community unless a rigid system of constant inspection is provided for. The Pennsylvania law declares that the addition of water or of ice to milk is an adulteration, and any milk obtained from animals fed on distillery waste is declared to be impure and unwholesome. The removal of the cream is also declared an adulteration. The law prevents the manufacture of any substance provided to take the place of pure butter fat. This is not a restriction on the sale of an adulterated butter, but is a total prohibition of the manufacture and sale of any substitute for butter, even if it be sold under its own proper name.

Continuing the list of States with laws against the adulteration of food, we have next Virginia and Wisconsin. The latter State has a very good law, which not only has a general provision but also enters into detail, especially in regard to dairy products, describing what shall be considered pure milk, or establishing a standard thereof, and stating how an adulteration of milk shall be proved, and how adulterated honey shall be marked. It contains penalties for the sale of unwholesome provisions and items in regard to the adulteration of foods and drugs, fraud in dairy manufactories, the form of label to be placed on dairy products, the strength of vinegar, etc.

*(To be continued.)*

* A lecture delivered before the Franklin Institute. From the *Journal of the Institute.*

## ON CHEMICAL LABORATORIES.*

By Ira Remsen.

On January 1 the Kent Chemical Laboratory was dedicated with appropriate exercises. The beautiful building was thrown open to inspection, and many passed through its rooms expressing admiration. Its plans were explained and a general account was given of the uses to which it is to be put. Honor, "as is most justly due," was paid to the generous donor, whose name from this day forth will be intimately associated with progress in chemistry in this country. The exercises of yesterday have led by an easy step to those of to day, and a chemist is called upon to give the convocation address. What theme more natural to him, or more appropriate, than "The Chemical Laboratory"? It is to this theme that I ask your attention My purpose is to treat the chemical laboratory, not from the material point of view, but in its broader aspects, as far as I may find this possible. I shall attempt to answer briefly three questions, and these are:

1. When and how did chemical laboratories come to be established in universities?

2. What part have chemical laboratories played in the advancement of knowledge?

3. What are the legitimate uses of the chemical laboratory of a university at the present time in this country?

The first laboratory ever erected for the teaching of chemistry—indeed, the first laboratory for teaching any branch—was that of the University of Giessen, Germany, which owed its existence to the enthusiasm of Liebig. The story is an interesting one, and especially instructive on an occasion such as this. Liebig was born in the year 1803. According to his own account, he had a hard time of it in the schools. He says: "My position at school was very deplorable. I had no ear memory, and retained nothing or very little of what is learned through this sense. I found myself in the most uncomfortable position in which a boy could possibly be; languages and everything that is acquired by their means, that gains praise and honor in the school, were out of my reach; and when the venerable rector of the gymnasium, on one occasion of his examination of my class, came to me and made a most cutting remonstrance with me for my want of diligence—how I was the plague of my teacher and the sorrow of my parents, and what did I think was to become of me—and I answered him that I would be a chemist, the whole school and the good old man himself broke into an uncontrollable fit of laughter, for no one at that time had any idea that chemistry was a thing that could be studied."

This was truly an unpropitious beginning, yet this butt of his school was soon contributing more to the development of chemistry than any one ever had before or than any one ever has since. Filled with the determination to study chemical things and phenomena, he left the school where he had been such a failure, and entered an apothecary shop, but at the end of ten months the proprietor was so tired of him that he sent him back to his father. As Liebig said, he wanted to be a chemist, not a druggist. He must have been about fifteen years of age when, in spite of his inadequate preparation in languages, he was received as a student in the University of Bonn, and from here a little later he went to Erlangen. But he appears not to have been much better satisfied at the university than he was in the apothecary shop. He speaks almost with contempt of the teachers under whom he studied. "It was then a very wretched time for chemistry in Germany," he says. "At most of the universities there was no special chair of chemistry; it was generally handed over to the professor of medicine, who taught it, as much as he knew of it—and that was little enough—along with the branches of toxicology, pharmacology, materia medica, practical medicine, and pharmacy." Referring to the equipment of the universities for the teaching of chemistry, he says: "I remember, at a much later period, Prof. Wurzer, who had the chair of chemistry at Marburg, showing me a wooden table drawer, which had the property of producing quicksilver every three months. He possessed an apparatus which mainly consisted of a long clay pipe stem, with which he converted oxygen into nitrogen by making the porous pipe stem red-hot in charcoal, and passing oxygen through it. Chemical laboratories, in which instruction in chemical analysis was imparted, existed nowhere at that time. What passed by that name were more like kitchens fitted with all sorts of furnaces and utensils for the carrying out of metallurgical or pharmaceutical processes. No one really understood how to teach it."

After a comparatively short sojourn in Erlangen, Liebig returned home, fully persuaded that he could not attain his ends in Germany. Some of the young men of that time had gone to Stockholm to study chemistry, attracted thither by the fame of the great Berzelius. But Liebig decided in favor of Paris. He was then seventeen and a half years old, and, as we have seen, he could not have been well prepared in chemistry, yet in a short time after his arrival, he made such an impression on Alexander von Humboldt that he was admitted to the laboratory of one of the most brilliant chemists of the day, Gay-Lussac. He had previously begun an examination on certain fulminating compounds to which his attention was first directed in a curious way at his home in Darmstadt.

Let me again use his own words: "In the market at Darmstadt I watched how a peripatetic dealer in odds and ends made fulminating silver for his pea crackers. I observed the red vapors which were formed when he dissolved his silver, and that he added to it nitric acid, and then a liquid which smelt of brandy, and with which he cleaned dirty collars for the people." Gay-Lussac gladly joined him in the investigation, and he gratefully refers to this opportunity. He acknowledges that the foundation of all his later work was laid in Gay-Lussac's laboratory.

And now to the main point. When Liebig was in his twenty-first year he received an appointment to a professorship of chemistry at Giessen through the influence of Von Humboldt. His opportunity had come. He determined to have a laboratory for teaching The great advantages he had reaped from his contact with Gay-Lussac showed him clearly that if students were to study chemistry at all, it must be in a well equipped laboratory in contact with a teacher. And so the first laboratory was built, and became one of the great forces of the world. Soon students flocked to the little university from all parts of the civilized world, and the most flourishing and powerful school of chemistry that has ever existed was rapidly developed. One of the most brilliant pupils of this school, the late Prof. Hofmann, of Berlin, in speaking of its influence, says: "The foundation of this school forms an epoch in the history of chemical science. It was here that experimental instruction such as now prevails in our laboratories received its earliest form and fashion; and if, at the present moment, we are proud of the magnificent temples raised to chemical science in all our schools and universities, let it never be forgotten that they all owe their origin to the prototype set up by Liebig." The foundation of this school marked an epoch not only in the history of chemical science, but in the history of science. The great success of this laboratory led naturally to the building of others, and in a comparatively few years a chemical laboratory, at least, came to be regarded as essential to every university. At first these were of necessity modest affairs. One of the earliest was that at Tubingen, in regard to which a curious fact may be mentioned. It appears that the ground available for Liebig's laboratory in Giessen was not altogether well adapted to its purpose, and in consequence one of the larger working rooms received light from only one side. When the laboratory at Tubingen was built later, that at Giessen was copied in every detail, even to the dark room, notwithstanding the fact that there were no buildings in the immediate neighborhood, and light in abundance was available.

As time passed, the era of the palatial laboratory was introduced. Probably we shall be very near the truth if we fix the responsibility of this era upon Bonn. Hofmann was called to Bonn from England, whither he had gone under the most flattering conditions, and before accepting the new call, he had, no doubt, received promises with reference to a laboratory. At all events, a building was erected much finer than anything in the way of a laboratory that had ever appeared. As is customary in Germany, the professor's dwelling rooms were in the building, and so beautiful were all the arrangements, that when the King of Prussia passed through at the time of the formal opening, he is said to have remarked, "I should like to live here myself." Soon after this Hofmann built the laboratory at Berlin, and again magnificence was the order of the day. Statues and carvings, and tiles and frescoes, took their place in the laboratory, and since then in Germany and France and Austria and Switzerland immense sums have been expended in the erection not only of chemical but of physical and physiological and petrographical, and anatomical, and pharmacological, and geological laboratories. While of late years there has perhaps been a reaction, and a tendency to somewhat simpler buildings than those that at one time were the fashion, it is still true that the laboratories are semi-palatial, and a strict economist might find ground for complaint, claiming that results as good might have been obtained at smaller cost. It would hardly be profitable to discuss this point here. In this country we cannot be said in general to have been extravagant in building laboratories; certainly not, if we keep the European standard in mind Most of the larger laboratories in this country are modest in their fittings, and the strictest economist could hardly find fault.

If we had the power to estimate the value of the work that has been done for the world by the scientific laboratories, it is certain that the money spent for them, however great the sum may be, would appear to us ridiculously small. The scientific method, as it is called, has been spread among men, and has changed the whole aspect of things. The influence of the laboratory is felt in every branch of knowledge. The methods of investigation have changed, and everywhere the scientific method has been adopted. Who can tell what an enormous influence this has already had upon the thoughts and actions of men, and what still greater influence is to be exerted? The laboratory has impressed upon the world the truth that in order to learn about anything it will not suffice to stand aloof and speculate, and that it is necessary to come into as close contact with that thing as possible. When the old philosopher wished to solve a problem, his method was to sit down and think about it. He relied upon the workings of his brain to frame a theory, and beautiful theories where undoubtedly framed, and many of these, probably all of those which had reference to natural phenomena, were far in advance of facts known, and often directly opposed to facts discovered later. Minds were not hampered by facts, and theories grew apace. The age was one of mental operations. A beautiful thought was evidently regarded as something much superior to knowledge. We have not learned to think less of beautiful thoughts or of mental processes, but we have learned to think more of facts, and to let our beautiful thoughts be guided by them.

And how did this come about? It is curious that the scientific method of work, which is altogether the simplest, should be the last to be adopted by the world, as it is by individuals. It would be impossible to determine all the causes that have led to this result, but one of the immediate causes is undoubtedly to be found in the fact that, at an early period in the history of the world, those who worked with their hands came to be looked upon as inferior to those who worked with their heads alone. This operated powerfully to keep those who were best fitted to advance knowledge from adopting the simplest method, viz., that of studying things. One who engaged in experiment did it surreptitiously, or lost caste.

Probably the most powerful force that first led men to experiment systematically was the conception of the philosopher's stone, and out of the labors of the alchemists sprang experimental science. Strange as it may seem, it was the love of gold that led to the development of scientific methods of investigation. In some way, probably through superficial observations, men came early to think it possible that the ordinary or base metals could be transformed into gold, and with this idea came the desire to experiment on the subject, and the experiments on this subject have been kept up until the present century. So that in one sense, certainly, it is not true that "the love of money is the root of all evil." While much folly was committed in the name of alchemy—as much folly is committed today in the name of chemistry, and of medicine, and of other lines of work—it is clear that the true alchemist was as ardent a worker as the world has perhaps ever seen; he was engaged in experimenting. He was teaching the world that the way to a correct knowledge of nature lies not in philosophy alone but through coming in contact with things of nature, and becoming personally acquainted with them. Paracelsus speaks of the alchemists of his time thus: "They are not given to idleness, nor go in a proud habit, or plush or velvet garments, often showing their rings upon their fingers, or wearing swords with silver hilts by their sides, or fine and gay gloves upon their hands, but diligently follow their labors, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreation, but take delight in their laboratory. They wear leather garments with a pouch, and an apron wherewith they wipe their hands. They put their fingers among coals, and into clay, not into gold rings. They are sooty and black like smiths and colliers, and do not pride themselves upon clean and beautiful faces."

This is certainly the picture of a hard worker, and as such we must look upon the alchemist. The work done by the alchemists was chemical work. It was allied very closely to the work done by chemists nowadays. They hoped to find the philosopher's stone among chemical substances, and the transformation they hoped for was to be accomplished by a chemical method. They consequently devoted themselves to careful study of all known chemical substances, and in further studying the action of these substances upon one another they came into possession of new facts. There can be no doubt that we owe to the alchemists not only the foundation of chemistry, but the foundation of experimental science. In our superior way we smile at their futile labors to discover the philosopher's stone, but the tremendous results reached by them must not be lost sight of. The theory of the philosopher's stone was shown to be false theory; but what of that? Probably many of the theories now held are false, but they are none the less valuable. An idea is of value if it leads to active work. Working hypotheses are the stepping stones of intellectual progress. The philosopher's stone was more than a stepping stone—it was a magnificent bridge. "Any idea," says Liebig, "which stimulates men to work, excites the perceptive faculty, and brings perseverance, is a gain for science, for it is work that leads to discoveries. The most lively imagination, the most profound wisdom, is not capable of suggesting a thought which could have acted more powerfully and lastingly upon the mind and powers of man than did the idea of the philosopher's stone. Without this idea chemistry could not exist to-day in its present perfection."

Let us now turn from the past to the present, and inquire, What is the province of a chemical laboratory in a university in this country? The first chemical laboratories had for their sole object the training of chemists, and consequently, the methods adopted in them were adapted to this end alone. Afterward, and indeed only quite recently, the importance of laboratory training in chemistry for those looking forward to the study of medicine came to be recognized; and, still later, the idea that such training might be made a valuable part of a general education appeared. At present, then, a chemical laboratory is called upon to furnish opportunities (1) for the general student who does not expect to become either a technical chemist or a teacher of chemistry; (2) for the medical student; (3) for him who expects to devote himself to the practice of chemistry, either in a chemical factory or in an analytical laboratory; and (4) for him who is to devote his life to teaching and investigation. In addition to furnishing these opportunities, it should also be a place in which investigation is constantly carried on by the teachers and advanced students.

As regards the teaching of chemistry to general students much might be said, but it will be possible to touch upon only a few points on this occasion. Most of the teaching is of this kind, and the subject is under active discussion. There can be no question that much of the work done in schools and colleges is highly unsatisfactory, many of the courses which are called scientific are most unscientific, and the student is often more harmed than benefited by his work. If a course in a science, whatever that science may be, does not tend in some degree to develop a scientific habit of mind in the student, it is not serving its legitimate purpose. If the experience of twenty-one years in teaching in college and university in this country is worth anything, your speaker, who has during that time had to deal with many students from all parts of the country, is justified in asserting that the minds of students who enter college are very far from being scientific, and the same can be said of most of those fresh from the colleges. By a scientific mind is meant one that tends to deal with questions objectively, to judge things on their merits, and that does not tend to prejudge every question by the aid of ideas formed independently of the things themselves. Perhaps an anecdote, though trivial, will make this clearer. In a book used by my classes for a number of years there was one error that served as a simple test of the condition of the students' minds. In the directions for performing a certain experiment, the statement was made that a blue solution would result at one stage. As a matter of fact, the solution referred to was always a bright green. Each student being required to write out an accurate description of what he had seen, each one in turn for a series of years described the green solution as blue, disregarding the evidence of his senses, and accepting the evidence of the printed word as more reliable. Occasionally one would appear whose conscience was troubled by the discrepancy, and who would boldly assert that the book must be wrong, but the number of these exceptions was insignificant. Surely this tendency to disregard the evidence of the senses is one that in the great majority of cases can be overcome. It would be better if it did not exist at all, and it probably would not exist if our educational methods were what they should be. We need teachers properly trained for carrying on scientific

* Address delivered by Prof. Ira Remsen on January 2, 1894, in connection with the opening of the Kent Chemical Laboratory of the University of Chicago, U. S. A.

courses in our schools and colleges, and one of the most important branches of work in a university is the training of such teachers. Many of the courses in schools and colleges are at present too ambitious. The attempt is made in them to do in a small way just what is done in a large way in the most advanced courses in the universities. Instead of being what they should be, school courses and college courses, they are reduced university courses. Young men who have had the advantages of advanced courses feel so plainly the benefits they have received, that they naturally wish their own students in turn, whatever their ages may be, to get the same benefits. But time will not permit further discussion of this topic, and the main object in referring to it at all is to make it clear that the university laboratory has a great field of work in connection with the improvement of methods of teaching chemistry.

The teaching of chemistry to medical students suggests a number of thoughts, but they are rather of a special character, and this branch of our subject may be passed over with the remark that there is practical agreement as to this point, that what the medical student most needs at first is good scientific training, and that a course in general chemistry is well suited to this purpose. The most recently established medical schools require training in chemistry as one of the conditions of matriculation, and it is distinctly understood that it is chemistry, and not medical chemistry nor physiological chemistry, that is wanted.

The relation of the science of chemistry to the chemical industries is suggested by the next division of the subject. Here a most instructive object lesson was afforded during the past summer by a visit to the chemical exhibits in Jackson Park, where for the time being the products of the earth were concentrated. If you had had an intelligent chemical guide, he would have pointed out many an interesting product from England, France, Russia, Italy, and this country, but his enthusiasm would have been reserved for the exhibit of the German chemical industries. He would have pointed out a great variety of beautiful and valuable products, and you would, I am sure, have carried away with you the conviction that the Germans excel the world in this line of work. The reason is not hard to find. It has often been discussed, but it would not be right to let this opportunity pass without again calling attention to it. Those who are familiar with the subject do not hesitate to acknowledge that the reason why the chemical industries have reached such a flourishing condition in Germany is that the pure science has been so assiduously cultivated. The value of pure science in the industries has long been recognized there, much more clearly than in any other country, and the scientific method has become established in the factories, much to their advantage. Men deeply versed in pure chemistry, whose minds have been clarified by training in the university laboratories, are eagerly sought for in the factories. So thoroughly convinced are the Germans of the value of pure science for the industries that in the polytechnic schools the plan of instruction in chemistry is essentially the same as in the universities, and some of the best purely scientific work is done in the laboratories of these polytechnic schools. We, in this country, have yet to learn the importance of this relation between science and industry, though undoubtedly some progress has been made in this line. We still endeavor to make iron and steel chemists, and soap chemists, and sugar chemists, and turn out hosts of raw products that are not worth their salt. Training along such narrow lines is a positive injury to the students. They are the victims of false pretenses. Let the training be as broad as possible and as thorough as possible, and the student will at least not be crippled when he ought to be strengthened.

Finally, a few words in regard to what is commonly and properly spoken of as the highest work of the university laboratory—the training of teachers and investigators. Here, again, we find that Germany leads the world, and to her we must look for guidance; and, as is well known, to her we have looked for guidance for many years past. Just as Liebig betook himself to Paris, and Wohler to Stockholm, so in turn Americans have betaken themselves to Germany to work with the great masters. This movement began soon after the establishment of the Giessen laboratory, and many an American obtained his inspiration in that laboratory. There are living to-day a number of American chemists who sat at Liebig's feet; a still larger number look back with pride to the time spent in the Gottingen laboratory, where Wohler's was for many years the master mind. Bunsen and Hofmann attracted large numbers in their best days; and now Bayer in Munich, Ostwald in Leipsic, Victor Meyer in Heidelberg, and Fischer in Berlin, appear to exert the strongest influence upon American students. Most of the chemists holding prominent places in this country have had more or less prolonged training in German universities, and it is not to be wondered at, therefore, that German methods have found their way into our laboratories. Indeed, there are some who appear to hold that, unless a method has a German tag on it, it is not worth considering. These hold, also, that the goal to strive for is the development of a laboratory like the best in Germany.

For many years Americans have been returning to this country after having enjoyed the best opportunities afforded abroad. Each annual crop have at least one thought in common, and that is, that chemistry in this country is in a deplorable condition, and that their labors are needed to bring about a reform. These young reformers are, of course, quite out of joint with the country, and often render themselves incapable of bringing about the results they desire, by refusing to recognize what is good and endeavoring to build upon that. The true and efficient reformer is a believer in continuity. Progress has always been by easy stages. The history of chemistry in this country shows that there has been a slow and steady advancement, and there is much promise in the present.

We owe to Germany very largely the investigating tendency which is showing itself more and more every year, and while even now the amount of original work done, as compared with that done abroad, is small, it is quite natural that it should be so.

A large part of the experimental work in Germany is done by advanced students and young chemists who are waiting for positions. It is by the aid of the former class especially that the professors work out their problems. Now, the number of advanced students of chemistry in this country is much smaller than in Germany, and the same is true even to a still greater degree of young chemists waiting for positions. Increase the number of these two classes here, and the amount of investigating work will be increased accordingly. But such increase must be determined largely by the demand, and the demand for thoroughly trained chemists is by no means as large as in Germany. The most important reason for this has already been spoken of. The value of these thoroughly trained chemists in the industries has not yet been generally recognized. Indeed, those particular industries in which the aid of scientific chemists is specially needed do not exist to any great extent, so that there is very little demand for such men. Most of the advanced students are looking forward to teaching, and the graduate departments in our universities must for years to come look to these men for re enforcement. Plainly, the number of such students must be comparatively limited, or the supply will exceed the demand. After completing their regular courses these students must secure occupation. The "bread and butter question" is involved. But the number of places to be filled is limited, and every year young men well fitted to take good places are left, at least for a time, without means of support, and all their efforts must go to securing positions; and, further, when they secure their places, the conditions are for the most part unfavorable to the carrying on of higher work, and although many of them struggle manfully for a time to keep up their enthusiasm, it gradually dies out for want of nourishment.

All this is discouraging, of course, to the advanced students of chemistry, and to those who wish to study chemistry, and thus the number is necessarily kept down. It is a fair question whether the number of graduates now studying chemistry is not unnaturally large. However this may be, it is clear that, as the amount of investigating work depends upon the number of advanced students, the amount of this work must of necessity be comparatively small. More could be done, no doubt, by teachers in colleges throughout the land, and the amount done by these teachers is increasing year by year, but it is difficult for them to secure co-workers, and with unaided hands the amount of chemical work that can be done by an individual is small.

Some of the most active workers in Germany are, as has been remarked, the young chemists, who are waiting for positions. These form a comparatively large class of picked men—men who have a strong tendency to investigation, and in some way see their way clear to at least a sufficient income to "keep body and soul together." Most of them have a hard struggle, though, on the other hand, some are men of means, whose ambition is not destroyed by the fact that they have fortunes. These men, of course, are desirous of securing advancement, and they know that their only chance lies in doing good work. It is the tremendous competition among these men that leads to the results for which Germany is famed.

Very well, you will say, if that is the secret, let us have that system here But that is the very thing we cannot get. We may be able to secure a few able professors, a number of bright advanced students, good laboratories, and supplies, but this intermediate class of active workers cannot be secured, save under conditions that do not exist here, and are not likely to exist here for many years to come. Abroad the university career is one of the most attractive open to men; a professor is a very much respected member of the community, and his life is an unusually pleasant one. Without entering into a detailed comparison between the university career in this country and abroad, we may accept the general statement that this career exerts a much stronger attraction upon students there than here. Then, too, the opportunities in other fields are more limited there, so that these two forces working together lead a number of the ablest young men to choose the university career, and to face the great difficulties which they know they will have to overcome before they attain success. The first condition of that success is good work done. There is absolutely no chance for one who does not carry on investigation, nor for one who is lukewarm in his work. The school is a merciless one, but the results probably justify the means.

What possibility is there of introducing this system in this country? Let the experiment be tried. Offer young men of ability the privilege of teaching in a university and nothing else, and how many, think you, will avail themselves of it? Or if some few exceptional men under most exceptional conditions should do so, how long will they remain in the position? To keep them it will be necessary to pay them at least enough to live on, and then the very soul of the German system is destroyed. In short, we have our own problems to work out under conditions that we cannot control, and while we may be inclined to regret that we cannot have all that we should like to have; while we in this generation at least must necessarily be content to do with less scientific work than those who have breathed the German atmosphere have been accustomed to, there is pleasure in working out new educational problems, and there is satisfaction in causing the tree of knowledge to grow where before it languished. We have a great field to cultivate. It is fertile. Labor expended upon it will yield rich harvests. So let us to work. These who have been in the chemical field for years welcome the new workers, and especially such a body of workers as has been brought together in this university. May the great activity in chemical work which has characterized this university during its short life continue unabated. The Kent Chemical Laboratory is already known of all the world, even before its doors are open. May its fame increase year by year.

## THE VELOCITY OF COMBUSTION OF GUNPOWDER AND SMOKELESS POWDERS.

MANY years ago Mons. De Saint Robert carried out some curious experiments with gunpowder, with the view of determining the velocity of its combustion. Briefly, his method was to fill a leaden tube with powder, and cut it into equal lengths; these lengths were then burned at various heights above the level of the sea. From the observations made, it was concluded that the velocity of combustion of gunpowder varied directly as the two-thirds of the pressure of the surrounding medium. Captain Castan has verified the increase of velocity of combustion with pressure by means of experiments with a tube containing powder. The tube was punctured with a hole for the escape of the gas, and by changing the size of this hole the pressure within the tube could be varied. Lieut. Glennon has now arrived at a formula by means of purely mathematical analysis which shows a close agreement with the results of De Saint Robert's experiments. This formula is—

$$V = K P^{\prime},$$

where V is the velocity of combustion, K a constant, and P the pressure of the gaseous surrounding medium outside the issuing stream of combustion gases. When the powder is burst in guns, the formula

$$V = KP^{\frac{1}{2}}$$

is a sufficient approximation to truth. Expressed in words, the principle involved in the equation is the following, viz., the velocity of combustion of gunpowder varies as the square root of the pressure of the surrounding medium. This principle is due to Mons. Sarrau. For smokeless powders, and for other explosives leaving no residue, in process of combustion as distinguished from detonation, the above equations should hold with exactness.—*Arms and Explosives.*

## PALLADIUM.

### DETERMINATION OF ITS ATOMIC WEIGHT—USES OF PALLADIUM CHLORIDE.

RECENT numbers of the *American Chemical Journal* contain reports of important experiments with palladium and some of its compounds.

The atomic weight of this metal has not yet been agreed upon, and the investigation of the subject by Edward H. Keiser and Mary B. Breed is given in detail. They have used palladammonium chloride as the compound most convenient for the determination of the atomic weight of the metal.

This was prepared from palladium dichloride, which cannot be used itself for the determination, on account of its deliquescence and the fact that the dichloride is partly changed into monochloride when melted. The dichloride, which had been several times distilled, was dissolved in distilled water, slightly acidulated with hydrochloric acid. Ammonia was slowly added and the solution was warmed over a water bath until the precipitate was dissolved. The solution was filtered, diluted with considerable water and had a current of pure hydrochloric acid passed into it. The precipitate thus formed was palladammonium chloride. It was thoroughly washed, then dissolved in dilute ammonia and again precipitated with hydrochloric acid gas. After being washed and dried in desiccators it was ready for use.

The compound was weighed in platinum boats. It was dried in an air bath at a temperature of 110° to 120°. The boat was then put into a combustion tube and a current of hydrogen which had been purified was passed over it. Three drying substances for the hydrogen were used: First, it was passed over solid caustic potash; next, over red-hot metallic copper; and lastly, phosphorus pentoxide. After the hydrogen, thus carefully prepared, had been passing through the combustion tube long enough for all the air to be expelled, the part of the tube holding the boat with the palladammonium chloride in it was gently heated. The chloride united with the hydrogen slowly. As the temperature is gradually raised, the ammonium chloride forms a snow-like sublimate. "There was absolutely no loss of palladium by volatilization nor decrepitation, as was shown by a careful examination of the aqueous and acid washings of the tube after the reduction was finished."

Five tests made to determine the atomic weight of the palladium, from the analysis of the palladammonium chloride, gave it as 106·246.

For the purpose of insuring accuracy, the experimenters purified some palladium in the wet way. Fifteen grains of palladium foil was dissolved in *aqua regia* and the dichloride thus obtained was evaporated to dryness. The residue was then dissolved in water slightly acidulated with hydrochloric acid, the filtered solution was treated with ammonia, and heated over a water bath until the precipitate was dissolved. The insoluble residue which contained iron and other impurities was filtered off; copper in the filtrate gave it a pale bluish-green color.

Very strong hydrochloric acid was then passed into the solution. Palladium diammonium chloride was thus precipitated. This was carefully washed by decantation and then on a filter with a suction pump and afterward dissolved again in very dilute ammonia. After repeating these processes of precipitation and solution five times, the rhodium, iron and copper were all removed. The salt was dried in desiccators and the metal was obtained by the use of hydrogen, as in the first experiment. Its purity was carefully tested, the small quantity of mercury detected was removed.

Analysis of the compound thus prepared gave for the atomic weight of palladium 106·245, a result differing only 0·001 from that obtained by the first experiment.

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It has been found that palladium chloride may be used as a reagent to detect free hydrogen in mixtures of gases. It is so delicate a test that nitrogen containing $\frac{1}{20}$ of 1 per cent. of free hydrogen will show its presence when passed over the palladium chloride into a solution of silver nitrate.

If air which contains any hydrocarbon (paraffine, olefine or acetylene) be passed over slightly heated palladium chloride, it is decomposed, hydrogen chloride being set free. If the temperature of the palladium chloride is not raised above 50 C., $\frac{1}{10}$ of 1 per cent. of hydrogen in the air can be detected.

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If palladium is oxidized by being heated in the air, it can be at once reduced by passing free hydrogen over it. Iridium dioxide is reduced to a metal if brought in contact with free hydrogen. This will take place in the cold and is attended with brilliant scintillations.

Mr. Francis Phillips, from whose paper these results of his experiments are gathered, says; "In point of

delicacy the palladium chloride reaction is superior to all others. Experiments are now in hand with a view to the utilization of this reaction for the quantitative determination of hydrogen."

Certainly no more valuable result of this investigation has been reached than that palladium chloride is the best reagent for the detection of carbon monoxide. Very small quantities of the monoxide in the air will cause the precipitation of metallic palladium from a solution of palladium chloride. The precipitate often forms a dark brown, lustrous metallic film on the glass. It is necessary to identify the carbon monoxide by lime water or some other test for carbon dioxide, which is formed by the action of the palladium chloride, lest the monoxide be mistaken for some member of the olefine group. The air which is being tested may be made to pass through the palladium chloride solution and then into lime water. The well known tendency of carbon monoxide to oxidize to the dioxide (which is not the case with the olefines, at a temperature of 100° or below) is a simple means for distinguishing between them. Platinum chloride may also be used for the recognition of carbon monoxide; the metal is not precipitated until the solution has been exposed to the gas several days.

## PLANT LIFE IN THE OCEAN.

WHEN we speak of plant life of the deep seas, we understand by the term only very small specimens of vegetable life of the simplest form, of which there is a most astonishing variety. The Kiel Plankton expedition has taught us that the sea is filled with such an immense number of microscopic representatives of the

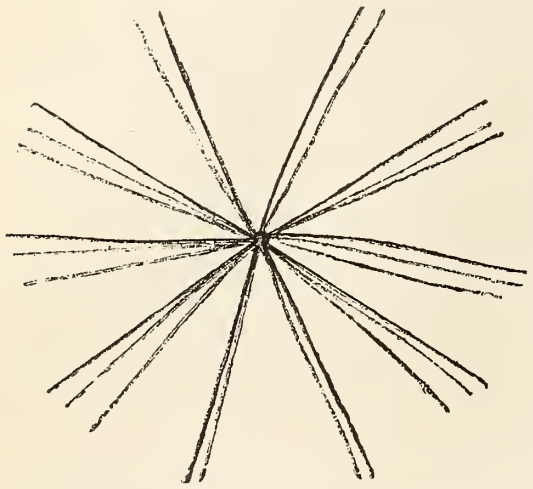


FIG. 1.—CHAETOCERAS BOREALE.

vegetable kingdom that the number of organic substances derived from them is nearly equal to that produced from plants on a land surface of equal size; and as the lower animals that serve as food for the larger and more highly organized creatures live almost exclusively on this abundant plant growth that increases so rapidly, it will be easy to understand the importance of the latter for the whole of Nature's housekeeping.

By far the greater part of the deep sea plants are siliceous algæ or diatomaceæ. Each such diatom is an individual that consists of only a single cell; which translated into popular language means that each siliceous alga corresponds to one of those billions of elementary bodies of which the organisms of all higher plants and animals are composed. In each diatom we have a plasm-mass that resembles the white of an egg, and a membrane that surrounds it, which, as in all plant cells, consists of cellulose, and in addition to these there is a case of silex, which forms a complete armor. These armor-like cases of the different genera present most varied and delicate forms, a study of which is most attractive even for the amateur microscopist, but only by the most careful observation can we find out the secrets of the siliceous algæ, the structure of which is varied according to the nature and needs of the individual diatom.

The covering of silex always consists of two similar

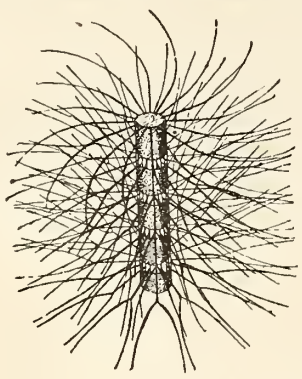


FIG. 2.—BACTERIASTRUM VARIANS.

valves, one of which is slightly smaller than the other, the smaller one fitting into the larger one as a pill box fits into its cover. A diatomaceous frustule or cell presents quite a different appearance when viewed from the front, in which case the connecting rim or hoop is seen, or from the side, when the valve is presented to the observer Inside of this wonderfully made armor we find the living and assimilating plasm body, that is, a little viscous substance which is either spread on the inner walls of the frustule or entirely fills it.

All bodies of water are more or less rich in diatomaceæ, and we often find rare specimens in an unpretentious pond or pool, but the classes found in fresh water are very different from those in salt water, and there is even a difference between those of the coast and those of the deep sea. While a majority of the former have a casing formed of two similar valves joined at the middle by a thickened portion, the diatomaceæ of the ocean are not provided with casings arranged in this manner, but the reason for this difference is easily understood when we examine this thickened portion under a microscope, for then we see that it is provided with a narrow slit by means of which the interior of the cell is brought into communication with the exterior world. Very careful examination of the larger species of the diatomaceæ has proved that a very

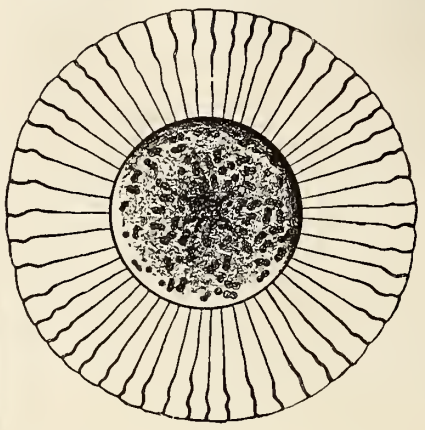


FIG. 3.—PLANKTONIELLA SOL.

fine fold of the plasm mass protrudes from this longitudinal slit, which enables the alga to fasten itself to its support, and also explains the slow, gliding motion that we have noticed in many diatoms. The diatomaceæ of the deep seas have no such individual movement, and therefore they do not need such an arrangement as that just described, but are provided with means for keeping them afloat in the water. In fact, they are admirably fitted for their conditions of life. By comparing the numerous species of ocean algæ it will be seen that they possess peculiarities by which the specific gravity of their frustules is made to very nearly approach that of the surrounding water. In an especially large species (Anteminellia gigas), which might be called the giant of ocean diatomaceæ, the buoyancy is due to an enlargement of the entire surface of the armor. This extraordinarily large diatom is drum-shaped, having a large cross section, and it is thereby prevented from sinking into deep water. They cannot live when deprived of light.

In other species, as, for example, the Chaetoceras (Fig. 1), there are horn-like or needle-like growths on the cell, and also enlargements of the upper surface, which, however, extend only in the direction of one dimension, length. In the Bacteriastrum (Fig. 2), in

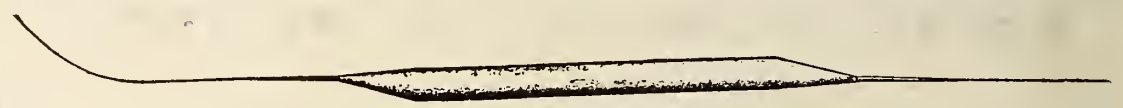


FIG. 4.—RHIZOSOLENIA SEMISPINA.

which the cells form a stiff, straight chain, such needle-like appendages are wound around the entire circumference of the siliceous casing, which not only give them buoyancy, but also serve as a protection from enemies which might find it a dainty morsel of food. The species named in honor of a former Prussian minister of education, etc. (Gossleriella tropica), is disk-shaped, and is provided with a thick wreath of thorns of a most decorative form. In the Planktoniella sol (Fig. 3) the girdle itself forms a hollow, flat wing which surrounds the circular frustule like the rim of a plate. These appendages which keep the frustules afloat remind one strongly of the wings with which many seeds of plants are provided for the purpose of keeping them floating in the air as long as possible, so that the wind can carry them a long distance. The seeds of the elm are formed in this way; they consist of a light wing or plate, the object of which is to increase the resistance offered to the wind, and the real seed is in the center of this plate.

But these types do not, by any means, exhaust the

FIG. 5.—PYXILLA BALTICA.

means for imparting buoyancy to the diatomaceæ. Let us glance at the Rhizosolenia genus (Fig. 4), and we find a simple rod-shaped frustule, the ends of which terminate in long, thin extensions that give it buoyancy. At first sight it would seem that these stiff, sharp appendages would have just the opposite effect, causing the frustule to sink quickly whenever the equilibrium of its contents was disturbed. for they would cut the water easily. This danger is prevented, however, by the arrangement of the long appendages, which do not extend in the direction of the axis of the frustule, but one is attached below and the other above the middle line, so that one always brings the other back into a horizontal position whenever the equilibrium of the frustule is disturbed. In exploring the waters of the Great Ploen Lake I was fortunate enough to find the Rhizosolenia genus in fresh water.

Another means of preventing the sinking of the rod-shaped frustule, or chains of them, consists in the curving of the separate cells or of the chains. Both of these formations occur in the Pyxilla baltica (Fig. 5), a species of algæ often found in the Baltic Sea. A bent frustule or a chain of them would always have the tendency to hold itself with the concave side up and the convex side down. The buoyancy is greatly increased thereby, the possibility of sinking being reduced to a minimum—provided always that the specific gravity of the frustules is nearly the same as

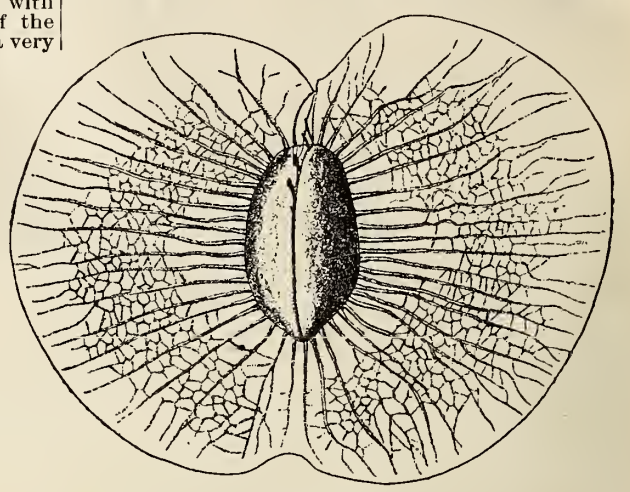


FIG. 6.—ORNITHOCERCUS SPLENDIDUS.

that of the water. The credit of having discovered these interesting facts in connection with microscopic plant life belongs to the botanist, Dr. Franz Schutt, a member of the Plankton expedition, undertaken by Prof. V. Hensen, in 1889.

The second main group of the plants of the deep seas is that of the peridiniidæ. Among these are also found single-celled, armored algæ, but the cell is not coated with silica; the casing usually consists of cellulose plates. The best way to obtain an idea of an organism of this kind is to think of a representative of the genus Ceratium, a tiny body that has exactly the shape of a two-armed anchor. Where the arms join the shank of the anchor there is a flat protuberance which contains the living portion of the cell.

The peridiniidæ differ from the diatomaceæ in possessing the means of active movement; being provided with two long flagella, which they can swing about like whips. Some of the peridiniidæ have most remarkable shapes, but these peculiarities of form are comprehensible when we keep in mind the fact that all of these grotesque lengthenings and wing-like broadenings of the frustule represent floating apparatus for holding the plant on the surface of the water. This is very essential for the perininiidæ as well as the diatomaceæ, for only in the light can they live and perform their proper functions.

Fig. 6 shows the Ornithocercus splendidus, one of the peridiniidæ that is provided with large side flaps which keep it afloat in the upper strata of the water.

Besides the two groups of deep sea plants just described, there are also bacteria and other growths of the ocean, These, however, are not nearly as numerous and are not of the same biological importance as the others.

The work of the Plankton expedition has proved that the real home of the diatomaceæ and the peridiniidæ is in cold waters. In the North and Baltic Seas, and also in the northern part of the Atlantic Ocean, the latter are abundant; at certain times of the year they are so numerous in the Baltic Sea that the other marine plants are of no more importance than the weeds in a well kept field of grain. In the warm waters inside of the Gulf Stream the plants of these two groups decrease toward the south until they form a very insignificant part of the animal and vegetable material floating on the ocean. — *Illustrirte Zeitung.*

[FROM KNOWLEDGE.]

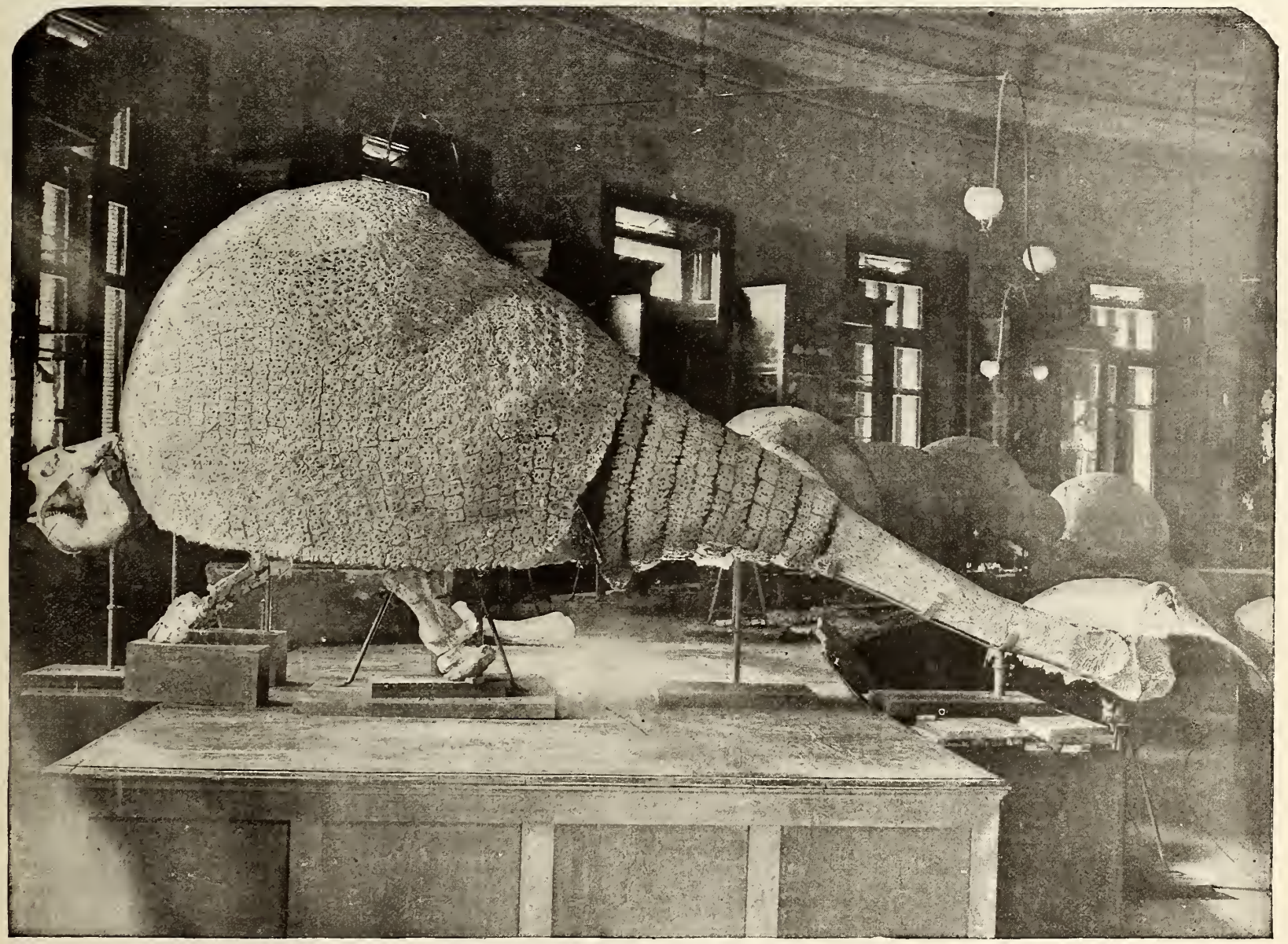
## THE MAILED MONSTERS OF ARGENTINA.

By R. LYDEKKER, B.A.Cantab.

AMONG all the extinct mammals of the Argentine, none strike the beholder with more astonishment than those gigantic cousins of the modern armadillos of South America, collectively known as glyptodonts; their name being derived from the peculiar sculpture with which the grinding surfaces of their molar teeth are ornamented. In a previous article, entitled "Armadillos and Aard Varks," we have already considered the leading characters of the great order of edentate mammals, of which the whole of the typical representatives are characteristic of South America, although a few of the extinct species wandered into North America during the Pleistocene period. We have likewise pointed out how the armadillos and their allies

differ from the other members of the order, and have likewise made some mention of the glyptodonts themselves. There are, however, such great differences between the various kinds of glyptodonts, which are sub-divided into several genera, that the group will well repay special investigation; and, indeed, no adequate conception of the extinct fauna of the "Land of Skeletons" could be given without devoting a separate article to these most curious animals.

As we have already pointed out elsewhere, both armadillos and glyptodonts differ from the other members of the order to which they belong in having their bodies protected by a bony shell or carapace, covering all but the under parts; the top of the head being covered by a similar bony shield, while the tail is incased in a series of bony rings, or in rings at the base and a long tube at the tip. Whereas, however, the armadillos (exclusive of the aberrant pichiciago, described in the article referred to) have a larger or smaller portion of the middle region of the carapace formed of movable transverse bands of plates, in the glyptodonts the whole structure is welded into a single piece. It must not, however, be supposed that this carapace consists of a single solid dome of bone, as, if it did, there would, of course, be no possibility of growth. On the contrary, the carapace, as shown in the beautiful figure taken from a photograph of the external skeleton of the largest member of the group preserved in the museum at La Plata, is composed of a number of polygonal or rhomboidal plates articulating together at their edges, and thus allowing of free



THE CLUB-TAILED GLYPTODONT. (ABOUT ONE-FIFTEENTH THE SIZE OF NATURE.)

growth. In very old individuals a considerable number of these plates may, however, become completely fused together. During life these bony plates were covered with small horny shields, as in the living armadillos; and they frequently show incised lines formed by the lines of union between such shields. For instance, in the members of the typical genus of the group, or ring-tailed glyptodonts, each bony plate was smooth and polygonal in shape, while the lines indicating the borders of the horny shields take the form of a rosette. Another important point of difference from the armadillos is to be found in the contour of the skull, which is short, deep, and rounded, instead of being long, flattened, and pointed at the muzzle. Then again, whereas the armadillos have small cylindrical teeth, those of the glyptodonts are large, and fluted at the sides, with their grinding surfaces marked by the aforesaid sculpture; while the whole series is in close contact, and forms one of the most efficient grinding machines imaginable. To support the enormous weight of the carapace, which in some of the larger kinds is considerably more than an inch in thickness, special modifications are needed in the internal skeleton. Here we find, for instance, as shown in the foregoing figure, that nearly the whole of the vertebræ are welded together, so that a large portion of the backbone forms a continuous solid tube. The vertebræ of the neck are also very short, and may be partially united, so that the movements of the head must have been somewhat limited. The reader will not fail to notice also the great strength and upright position of the haunch bones, and the powerful build of the legs and feet: the latter terminating in five toes, armed with broad flattened nails. As an illustration of the various modifications of the same general plan of structure in use in the animal kingdom, it may be well to point out how essentially the arrangement of the armor of a glyptodont differs from that of an ordinary tortise or turtle. In the latter the carapace is completely welded to the ribs, which are situated externally to the haunch and shoulder bones; whereas in a glyptodont there is no sort of connection between the carapace and the ribs, while the latter are internal to the haunch and shoulder bones. In these respects the leathery turtle holds a somewhat intermediate position between ordinary turtles and the glyptodonts, the carapace being composed of polygonal plates totally unconnected with the ribs, while the latter are situated externally to the bones of the shoulder and haunch.

Not less remarkable are the modifications of the vertebræ of the tail for the support of the rings or tube with which the latter is incased. In the first place, most of the vertebræ of this region are welded together so as to form a hollow tapering rod; while from each segment are given off radiating processes upon which the bony plates are borne, and as the whole of the latter are firmly welded together, the entire structure is of great strength.

When standing with the edges of its impenetrable carapace resting on the ground, its mail-crowned head partially withdrawn within the front aperture of its shell, and only the lower portions of the limbs exposed, a glyptodont must have been safe from all foes save savage man, and even he must have had a tough job to slaughter the monster, if indeed he ever succeeded in doing so. That man did exist with the later glyptodonts, or those which flourished during the deposition of the Pampean mud, is, however, proved by more than one kind of evidence. For instance, crude drawings of these animals have been found incised on some of the rock surfaces of Patagonia, while in other cases human implements have been disinterred side by side with the bones and shells. Probably the empty carapaces of the larger members of the group were employed by the primitive inhabitants of Argentina as huts, and it is said that they are sometimes even so used at the present day by the Indians. That these animals were not killed off by any living foe—either human or otherwise—may be taken for granted; and we must therefore conclude that this result was probably due to the unknown causes alluded to in the first of this series of articles as having brought about the extermination of the larger Argentine mammals. It may be well to mention that although some of the living armadillos are carnivorous, it is perfectly evident from the structure of their teeth that all the glyptodonts subsisted exclusively on a vegetable diet.

The earliest known representatives of the group occur in the older Tertiary beds of Patagonia, and may be designated pygmy glyptodonts, although they have received the uncouth name of *Propalæhoplophorus*. These creatures, which lived side by side with armadillos nearly akin to existing forms, were the dwarfs of their race, the carapace not being more than a couple of feet in length. The plates of the carapace were smooth and ornamented with a rosette-like sculpture, of which the central ring in the fore part of the shell was raised into a prominent boss. In the form of these plates, as well as in the circumstance that the tail was surrounded from base to tip with a series of knobbed rings, these pygmy glyptodonts resembled the ring-tailed glyptodonts of the pampas, of which they may accordingly be regarded as the ancestral type. In the intermediate deposits of Monte Hermoso we meet with other glyptodonts which, while much larger than those of the Patagonian beds, were generally inferior in this respect to the giants of the Pampean; some of the species being nearly allied to the small Patagonian representatives of the group, while others belong to the same genera as those found in the pampas.

Passing on to a survey of the leading types of these creatures found in the alluvial mud of the pampas, where they occur in great numbers, we may first notice the one to which the name glyptodont was originally applied. The carapace in this form is characterized by the polygonal plates being nearly smooth and marked by a rosette of incised lines, while those along the margin are raised into a series of bold knobs. In general contour the whole carapace forms a nearly regular oval dome, while the plates on the back of the head were knobbed and ridged. Although in the specimen first sent to England the tail of another species was unfortunately affixed to the carapace, it is now known that the armor of the tail took the form of a number of rings, gradually diminishing in diameter from the root to the tip, and severally ornamented with a series of conical knobs, thus forming a protective case against which little short of a steam hammer would have been of any avail.

Although one might have thought that these ring-tailed glyptodonts, as they may be conveniently termed, were sufficiently large and *bizarre* to have stood alone in the world, they were exceeded both in size and strangeness of form by the extraordinary creature of which the external skeleton is represented in the accompanying plate. In this stupendous monster, which measured upward of eleven feet eight inches in a straight line, the carapace is characterized by its peculiar hump-backed form, while its margins lack the prominent knobs characterizing those of the preceding group. On closer examination it will be found that each of the component plates of the carapace, instead of being polygonal and marked by a rosette of lines, is rhomboidal and pierced by from two to five large circular holes. From the analogy of the living hairy armadillo—known in Argentina by the name of peludo, or hairy animal—it is quite evident that during life the holes in the plates of the carapace of the extinct monster, which, by the way, may be known as the "club-tailed glyptodont," or technically as *Dædicurus*, must have formed the exits of large bristles, which were equal in diameter to a cock's quill, and were doubtless many inches in length. The whole body of the animal must, therefore, have resembled a gigantic porcupine. Still more extraordinary is the conformation of the huge tail, which had a length of about five feet. At its base this appendage was en-

circled by about half a dozen double bony rings, nearly as large at the base as the iron hoops in the middle of an ordinary beer barrel; their component plates being pierced by the aforesaid holes for bristles. The whole of the terminal half of the tail is formed by one continuous piece of hollow bone, which, if we exclude whales, is one of the most massive bony structures in the animal kingdom, and is almost as much as a man can lift. Starting at its base in the form of a nearly cylindrical tube, this sheath rapidly expands at the sides and becomes flattened on the upper and lower surfaces, until at the tip it finally assumes the form of a depressed flattened club, which would have formed a most efficient weapon for a giant. Along the sides of its extremity this club is marked by a number of oval depressed disks, showing a sculptured pattern of ridges and grooves radiating from the center, and some of them attaining a length of six or seven inches. From the structure of their sculpture it is quite evident that during life these disks must have formed the bases of huge horns projecting at right angles to the tail, which must thus have formed a veritable *chevaux-de-frise*. If, as is quite probable these horns were as long as those of the common African rhinoceros, the tail of the dædicurus must have presented a most extraordinary appearance as it dragged on the ground behind its owner (for it is impossible to believe that any muscles could have raised such a stupendous structure). The use of these horny appendages is, however, hard indeed to divine, since the creature was amply protected by the underlying bone; and it is therefore probable that they must come under the category of ornamental appendages. Be this as it may, with its bristle-clad body and horned tail, the club-tailed glyptodont may well lay claim to the right of being the most extraordinary looking creature that ever walked this earth during the whole duration of the Tertiary period. Another species belonging to the same genus, of which the remains are found in the Tertiary beds of Monte Hermoso, is remarkable for possessing a cone-shaped aperture in the middle of the hinder part of the carapace, of which the only conceivable use is that it acted as the point of discharge of a gland.

Nearly equal in size to the Pampean representative of the preceding genus, but distinguished markedly by the characters of the skull and the more regularly dome-like form of the carapace, is another monster from the pampas, which has been described under the name of *Panochthus*. Although the plates of the carapace have the same oblong form as in the club-tailed glyptodont, they lack any perforations for bristles, and are marked by a number of patches of minute tubercles, so that this species may be spoken of as the tuberculated glyptodont. Doubtless the carapace was covered during life by thin horny shields, although the marks of these are not generally shown on the bone; and, from the absence of bristles, the creature must have been as smooth as the small existing mulita, or three-banded armadillo. The tail was much smaller than that of the club-tailed species, consisting at the base of a number of relatively small rings, and terminating in a tube of about a yard in length. This tube lacks, however, the terminal expansion and flattening of that of the preceding form, while the large disks with which it is ornamented take the form of prominent rough bosses, which probably carried flattened horny knobs, instead of spines, during life.

The last representatives of the group to which we shall allude are much smaller species from the deposits of Monte Hermoso and the pampas, which may be known as the smooth-tailed glyptodonts, or, technically, *Hoplophorus*. In these creatures the carapace was much more elongated and depressed than in the other kinds, while it projected forward on the sides of the shoulders in a manner somewhat like that of the armadillos. The plates of the carapace show a rosette pattern, not unlike that of the ring-tailed glyptodonts, but they are still smoother, and of an irregular oblong shape. As regards the tail, this consisted at the base of a number of smooth rings, fitting into one another at their junctions like the joints of a telescope, while at the end it terminated in a slightly flattened tube ornamented with a number of small, smooth, oval disks of about an inch in diameter, interspersed with which were arranged a few much larger but equally smooth and prominent disks along the sides. These disks of all dimensions were evidently coated with smooth scales of horn during life, and, from the absence of apertures for bristles, the same smoothness doubtless characterized the carapace. The head was protected by a smooth shield of small tesselated plates, and the skull is characterized by the peculiar twisting and curvature of the bones of the nose.

In conclusion, we must not omit to mention that a strange gigantic armored creature, found commonly in the cavern deposits of Brazil, and also rarely met with in Argentina, seems to have been a kind of connecting link between the glyptodonts and the armadillos, having the carapace formed of a number of movable plates, arranged in a series of overlapping bands as in the latter, but with teeth of the type of the former. Unfortunately, however, this interesting creature, which must have been as big as a large rhinoceros, is known by such fragmentary remains that its full affinities cannot yet be determined, as we are still ignorant whether its skull approximated to the glyptodont or the armadillo type.

[Continued from SUPPLEMENT, No. 961, page 15365.]

## EXTINCT MONSTERS.*

A BRIEF ACCOUNT OF SOME OF THE MOST REMARKABLE FORMS OF ANIMAL LIFE IN THE PAST HISTORY OF THE EARTH.

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### THE MAMMOTH.

WHILE the monsters that we have described in previous chapters perished many ages before man appeared on the earth, and have never been seen by him alive, the monster of which we are now about to write has been seen by man and its flesh eaten by him. That, however, was after it had been entombed for untold ages in the ice of arctic regions. The remains of the Mammoth are widely diffused over the earth. They have been found in great abundance not only in North America, but also in the frozen regions of Siberia, and indeed all over Asiatic Russia. They are found in England, Ireland, Germany, Poland, Russia, Greece, Spain, and in Africa and Asia. The science of paleontology was founded largely on the remains of the Mammoth. In an ancient Chinese work dating some 500 years B C., the Mammoth is spoken of, and the Chinese seem to have had a knowledge of their frozen remains in arctic lands. For a long period they have obtained supplies of Mammoth tusks from northern Siberia. As far back as the tenth century an active trade has been carried on in fossil ivory. It is estimated that during the past two centuries more than two hundred pairs of fossil tusks have come into the market annually, and the localities where found are far from being exhausted. After more than forty thousand pairs have been obtained from northern regions, the traveler finds them increasing as he approaches toward the north pole. It is said that the soil of Bear Island and Liachoff Island, New Siberia, consists of sand and ice with such quantities of Mammoth remains that they appear as if they were made up of bones and tusks.

But not only have the fossil remains of the Mammoth been found all over arctic lands as far as man has penetrated, but their bodies, as we have intimated, have been found intact frozen and preserved in the ice. In the year 1800 the entire body of a Mammoth was discovered in a vast stratum of ice on the banks of the river Lena. Afterward it became disengaged from its icy matrix, and white bears, wolves, foxes and dogs fed off its flesh. It was a male and had a long mane on its neck. Six years after its discovery Mr. Adams visited the spot and found most of the carcass remaining. Polar bears and other animals had trampled the long hair into the earth, but he recovered about sixty pounds weight and brought it away, with the eyes and a portion of the skin which are preserved in the St. Petersburg museum. The skin was of a dark gray color, covered with black hair and reddish wool. The ears were covered with tufts of hair.

A young Russian engineer named Benkendorf, in the employ of his government, ascended the Indigirka in a steamer in 1846. The season was unusually warm for Siberia, and the country was flooded with water. The stream, which was greatly swollen, cut new channels in many places, melting the ice and frozen soil. In one of these newly cut channels he discovered a Mammoth in an upright position, where it had been overwhelmed probably thousands of years previously. As its head and trunk rose and fell with the surging waters he discovered that it was still fastened in the ice and frozen soil by its hind feet. The monster was secured by throwing ropes and chains over its tusks and head, and after its hind feet were released it was safely landed by the aid of more than fifty men and horses. It proved to be of gigantic size, and the whole body was in a fine state of preservation. In its stomach was found the food that had formed its last repast, which consisted of young shoots of the fir and pine, also young fir cones. On the shoulders and along the back grew stiff hairs about a foot long. The hair was dark brown and coarsely rooted. Under the outer hair there appeared everywhere a soft, warm and thick wool of a fallow brown color.

The question naturally arises, What causes operated in the extinction of these mousters? This is answered, and correctly we think, by the great naturalist Cuvier. He says the Mammoths could not possibly have lived in Siberia as that country is now; and that at the very moment when the beast was destroyed the land was suddenly converted into a glacial region. This sustains the recently developed Vailian or annular theory in accounting for their destruction. His exact words are: "C'est donc le même instant qui a fait périr les animaux, et qui a rendu glacial le pays qu'ils habitaient, cet événement a été subit, instantané, sans aeune gradation."* Glaciers were formed in olden time by the declension of annular vapors, and the downrush was sudden and overwhelming, bringing instant death to all animal life. Although this could not have occurred later than the Noachian deluge, yet many of the animals, as the Mammoth, Rhinoceros, etc., remain undecayed. Even the capillary blood vessels still retain their contents, showing that there was not the slightest decomposition or breaking down of the tissues, but the catastrophe which overwhelmed them was sudden. The climate was changed as by a stroke which congealed and sealed the land in ice, locking the Mammoth and other animals therein to repose in icy beds for ages to come. Had these animals not been frozen as soon as killed, putrefaction and decomposition must have taken place. Nothing but the downrush of snows from the earth's annular system could have done this.

The Mammoth attained immense size. Some full grown males were eighteen feet high and twenty-five feet long. The tusks were ten feet long and greatly curved. Their strength was prodigious.

### THE MASTODON.

We shall probably be able to show that it has but recently become extinct, if indeed it is not still living.

The principal difference between the Mastodon and the Mammoth lies in the teeth, though there are other structural differences. The teeth of the former contain rough mammillations on the surface, and from which it derives its name—Greek, *mastos*, teat; *odons*, *odontos*, tooth. The teeth of the Mammoth are like those of existing Indian elephants, having a broad united surface with regular furrowed lines. Mastodon's teeth have been found weighing sixteen or eighteen pounds each. As many as twenty-six species of this pachyderm have been identified. It was larger than the largest existing elephant, and it was more widely diffused over the earth than the Mammoth. It has been found as far north as latitude 66°. It seems, however, to have been more adapted to the temperate zone than the latter. The two enormous tusks of the upper jaw reached a length of more than ten feet, and it also had two smaller tusks projecting from the lower jaw.

Another singular fact is that the remains of the Mastodon are found in much earlier formations than those of the Mammoth. It came into existence as early as the Miocene period, and seems to have outlived the Mammoth and was doubtless contemporaneous with early man. When its bones were discovered some two hundred years ago, they were believed to be those of giant men.

That the Mastodon was known to the North American Indians is beyond doubt. Those inhabiting this country a century ago had many traditions concerning it. Sir Henry Howorth in his work on the Mammoth and the Flood says that in 1762 the Shawnee Indians found the skeletons of five Mastodons about three miles from the Ohio River, and they reported that one of the heads had a long nose attached to it, below which was the mouth. Other discoverers report similar finds, indicating that portions of the skin and hair have been seen. Dr. Koch in an article published in the *American Journal of Science* reports the discovery of Mastodon remains in which the head and one foot were well preserved, also large pieces of the skin which looked like freshly tanned leather. Dr. Barton, of the University of Pennsylvania, reported finding with Mastodon remains a mass of vegetable matter composed of small leaves and branches, among which he recognized a species of rush still common in Virginia, and upon which the animal had fed just previous to its death.

Thomas Jefferson in his Notes on Virginia says that a delegation of Delaware Indians visited him while he was governor, during the revolutionary war, and before their departure he inquired of them concerning the bones that had been found at Great Bone Lick near the Ohio River; whereupon they related to him the traditions of their fathers, which clearly pointed to the Mastodon, and which they believed still lived in the far North. Mr. Jefferson also relates that a Mr. Stanley was taken prisoner by Tennessee Indians and was carried over the mountains west of the Missouri to a stream that ran westwardly, on the banks of which large bones occurred, and that the natives described the animal to him in a way that indicated the Mastodon or Elephant, which they said still existed toward the north.

Prof. Mather in the fourth volume of the Natural History of New York says that Mr. Stickney, who was for many years Indian agent for the tribes northwest of the Ohio, said that the Indians had traditions of living Mastodons that fed on the boughs of a species of lime tree; that they did not lie down when they slept, but leaned against trees.

Prof. John Collett, State geologist of Indiana, says a skeleton of a Mastodon was found in Fountain County in that State, in a fine state of preservation, bedded in wet peat. When the large bones were cut open the marrow was found well preserved, and was utilized by the bog cutters to "grease" their boots, and that chunks of a sperm-like substance two and a half by three inches in diameter (adipocere) occupied the place of the kidney fat of the monster. The same authority says that the skeleton of a Mastodon was found in Iroquois County, Illinois, which goes far to settle the question not only that it was a recent animal, but that it survived until the life and vegetation of to-day prevailed. A mass of fibrous bark-like material was found between the ribs filling the place of the animal's stomach. It proved to be a crushed mass of limbs and grasses similar to those which still grow in the vicinity. In the same bed were found land and fresh water shells that exist alive in that locality at the present time.

For years the Indians of Alaska have contended that animals are living in the wilds of that country which according to their description correspond with that of the Mastodon. A late number of the Juneau *Free Press* says:

The Stikeen Indians positively assert that within the last five years they have frequently seen animals which, from the descriptions given, must be Mastodons. Last spring while out hunting one of these Indians came across a series of large tracks, each the size of the bottom of a salt barrel, sunk deep in the moss. He followed the curious trail for some miles, finally coming out in full view of his game. As a class these Indians are the bravest of hunters, but the proportions of this new species of game filled the hunter with terror, and he took to swift and immediate flight. He described the creature as being as large as a post trader's store, with great, shining yellowish white tusks and a mouth large enough to swallow a man at a single gulp. He further says that the animal was undoubtedly of the same species as those whose bones and tusks lie all over that section of the country. The fact that other hunters have told of seeing these monsters browsing on the herbs up along the river gives a certain probability to the story. Over on Forty-mile Creek bones of Mastodons are quite plentiful.

Those who have claimed a high antiquity for Man have brought forward the fact that his bones and his implements of warfare have been found with the bones of the Mastodon. But instead of proving his antiquity, it simply proves the fact that the Mastodon has recently existed in North America. Both Man and the Mastodon have doubtless been contemporary within the last thousand years in the New World, and possibly are at the present time.

### MONSTER BIRDS.

Among the extinct monsters whose remains lie buried in the rocks, few possessed more attractive features than the giant birds. The Moa bird, of New Zealand, stood from twelve to sixteen feet high. Its leg bone (tibia) was considerably more than three feet long, while that of a tall man is but one foot four inches in length. Large and unwieldy as it must have been, weighing several hundred pounds, it seems to have existed in large numbers. As many as fifteen species have been identified, and the bird has but recently become extinct, if indeed it is not still living in the almost inaccessible mountain regions of New Zealand. The natives retain traditions of this monster bird, and celebrate them in their songs.

A great find of the remains of the Moa occurred in New Zealand in the autumn of 1891. They are said to represent at least five hundred birds. How such a vast number perished in one spot is left only to conjecture. When living the bird carried in its crop a quantity of stones to assist in grinding its food. These stones are often found, and are called Moa heaps. We found in the crop of an ostrich a large number of

* From the author's pamphlet.

* Ossemens Fossiles, Vol. I., p. 108.

quartz pebbles, amounting to probably fifty, which we presume were used for the same purpose, and seem to be common with this class of struthious or running birds.

In Madagascar the remains of another large bird have been found, belonging to the same type. Here their eggs have been found in a good state of preservation, some of which are more than a foot in diameter and will hold over two gallons. They occur in the mud of swamps, and the natives find them by probing with long iron rods.

It is a remarkable fact that remains of giant land birds of nearly the same character have been found occupying areas widely separated. We may mention the Moa of New Zealand, the Æpyornis of Madagascar and the Dromornis of Australia. These are strictly land birds, without the ability to fly or swim, and the widely separated areas in which they are found can only be accounted for on the supposition that these regions were once united and that subsequent geological changes have covered the intervening area with seas. Even in the Eocene strata of New Mexico the remains of large wingless birds have been found. These great struthious birds seem to have begun their existence far back in the Tertiary era, and in time had a wide geographical range. Their remains are found in nearly every continent, and on many of the islands, which may indicate the vast changes that have taken place in the land surface of the globe since their advent.

A story comes from Berlin that the Ornithological Society of Germany has discovered the Moa alive on the north island of New Zealand, but at this writing it lacks confirmation.

### ADDITIONAL EXTINCT FORMS.

*A Monster Deer.*—In late geological times there appeared in Ireland, England and the Continent a gigantic deer, popularly known as the "Irish Elk." It seems to have been more numerous in Ireland than elsewhere. Its remains are found there in great abundance. It was a veritable deer, but of enormous size. It stood twelve or fourteen feet high, and its horns measured twelve feet from tip to tip. The skull and horns weighed nearly one hundred pounds. The vertebræ of the neck were necessarily large in order to support the vast horns. It must have had a vigorous circulation, for it doubtless shed its horns annually, as do other deer, and the osseous matter of which they were composed must have been drawn from the blood and carried by arteries to the head. In the bed of an old lake, now filled with peat, more than one hundred heads of this monster were found, which indicates, to some extent, the vast numbers that once inhabited the Green Isle.

*The Early Horse.*—The horse cannot properly be classed among monsters, yet its early history, obtained from the leaves of the Great Stone Book, is full of interest, and may properly be noted here. The horse made its appearance in Eocene times. The earliest remains are known as Eohippus, or dawn horse. Then, in the next succeeding age, the Miocene, we have Mesohippus, and toward its close Miohippus. After this come Protohippus and Pliohippus, both in the Pliocene period, and Equus in Quaternary times. The early forms were not larger than a fox, and what is still more singular, they had in front four perfect toes and three behind. This was especially true of Orohippus. In Eohippus, or dawn horse, there are rudiments of a fifth toe. In Mesohippus the fourth toe is wanting, except a small splint bone, which is not found in Protohippus. In Pilohippus but one toe is found, which is slightly split, and a small splint bone, which is found on each side of the leg, as in the modern horse. Equus, or the recent horse, has one solid toe. In the early horse the ulna and the fibula were free, that is, they were two distinct bones, but as we ascend in the species they begin to unite, or become soldered together, and finally become one bone. It seems strange that the progenitors of the horse tribe were little larger than house cats, and had three or four or five distinct toes on each foot. But the geological record shows this to be true beyond doubt. Mesohippus and Miohippus were about the size of a sheep, and Protobippus was about the size of an ass. From these forms have been evolved the present noble animal so useful to man. The remains of forty species have been found, some of the later rivaling in size the horse of to-day.

*A Strange Animal.*—The Miocene and Pliocene strata of Germany, France, Greece, Asia Minor, and some other regions furnish us with the remains of a strange animal called the Dinotherium. It derives its name from the Greek, "deinos," terrible, and "therion," beast. The animal when full grown was probably eighteen or twenty feet long, and of elephantine proportions. The head alone was nearly four feet long. It had two enormous tusks in the lower jaw turning down like those of a walrus. It also had a trunk similar to the elephant. The jaws had five molar teeth on each side. The animal partook of the character of the elephant, hippopotamus, tapir, and the dugong. It probably lived in the water, or was at least amphibious. Its great curving tusks would serve not only to dig up the roots of plants at the bottoms of lakes, rivers or shallow seas, but also assist it in climbing banks to the dry land, or, as some naturalists believe, to hook into the earth on the margin of streams while its ponderous body remained in the water, and in which position the animal rested or slept.

*A Monster Covered with Wool.*—The Tertiary period has yielded the remains of a singular animal known as the Woolly Rhinoceros. It attained a length of twelve or more feet, with corresponding height. It supported two large horns, one on its muzzle and the second just back of the first. It was stoutly built, and must have been able to defend itself against the attacks of other animals. Doubtless the Mastodon found it no trifling foe. The body of the Woolly Rhinoceros has been found intact in the frozen soil in Siberia, where it was probably overwhelmed by a downrush of snow and ice from overcanopying vapors thousands of years ago, and has been preserved in the ice to the present day. The animal had long hair or wool, which formed a complete covering for its body and legs, and even its feet. The skin itself was smooth, and did not lie in folds or wrinkles, as is common with the modern Rhinoceros.

*Ancient Whales.*—In the Eocene period a large cetacean made its appearance in vast numbers. It was between the Whale and the Seal in its relations. The teeth were yoke-like in appearance, from which the animal derived its name, Zeuglodon—Greek, "zeugle," yoke, and "odont," tooth—being apparently yoked in pairs. It attained a length of seventy or eighty feet, with vertebræ a foot or more in diameter. Their remains are found in some of the Southern States. In places its bones are so numerous that they have been used to construct fences. It would seem that vast numbers had been stranded by some great tidal wave, or other cause, on the shores of the Mexican Gulf. This great whale-like monster probably disappeared before the close of the Miocene period.

*The Early Fishes.*—The first Fishes made their appearance near the close of the Upper Silurian age. But they were generally quite different in appearance to those now living. In the Devonian, which was preeminently the age of Fishes, there was a fish that was covered with bony plates and swam by means of wing-like fins. Another was covered with bony plates in front, but its tail was bare and was used for locomotion. Some were covered with shields of rhomboidal plates. Others had blade-like teeth, and some had teeth like the claws of an animal, while others had mouths paved with rounded teeth like cobble stones. In these early Fishes the tail fin was vertebrated, and they possessed many characteristics of reptiles. Afterward a separation seems to have taken place, and one branch developed into true Fishes and the other into Reptiles. The first Fishes were air-breathers, and appear as the connecting link between Fishes and Reptiles. It must be confessed, however, that the Shark family known as Selachians were among the first Fishes, and differed but little from the modern Sharks known as Squalodonts. In Tertiary times huge Sharks were the chief rulers of the seas. The phosphate beds of South Carolina contain vast numbers of their remains. We have in our possession a tooth that would nearly cover an ordinary printed page. It is six inches long and five inches wide, and it is said that some are even larger. Think of a monster that could carry two or three hundred such teeth in its mouth! It probably represents a creature one hundred or more feet in length. At one time they must have been sufficiently numerous to nearly clear the seas of other forms of animal life.

*A Remarkable Sirenian.*—The most remarkable of the Sirenia family is what is known as Steller's Sea-cow. It was so called because it was first discovered by the German naturalist Steller, who, in company with Bering, a captain of the Russian navy, with his vessel and crew, was cast away on Bering Island, where the latter died in 1741. Steller saw it alive during his long enforced residence on the island, and became familar with its habits. He says the Sea-cows fed in the shallow water along the shore, and collected in herds like cattle. They ate the seaweeds that grew there, raising their heads above the water every few minutes to obtain fresh air. They were slow in their movements and mild and inoffensive in disposition. In color they were dark brown, sometimes spotted, and when full grown reached a length of thirty-five feet. They seemed much attached to each other, and when one was harpooned the others tried to rescue it. In Steller's time the animal was limited to two islands, and seems to have entirely disappeared about 1780. They were exterminated for their flesh and hides. The body was very large, requiring forty men to drag it from the water. Sirenian remains have been found from the Eocene period to the present time.

## FOREGLOWS AND AFTERGLOWS.

By Dr. J. G. MCPHERSON, F.R.S.E.

MEN do not wonder at the adoration by the savage of the sun; for to the untutored mind the majesty of that orb eclipses all. Among created things the sun is likest a god, shedding, on its way of glory, beauty, life and joy in unlimited profusion. To the eye of the artist nothing in nature can compare to a sunrise or sunset in certain seasons. And to educated theists the sun is the

"Creator's crest upon His azure shield the heavens."

By the sun's benignant beams of light and heat the earth rejoices to-day, as it has ever done since, by the divine *fiat*, it became the center of our system. The world's unwithered countenance is bright as at creation's day. The sun is always the joy-inspiring element in nature—the source of the rainbow colors on the dark cloud. And no man has more beautifully described the sun than did the poet king of Israel in those oft-admired words: "The sun, which is as a bridegroom coming out of his chamber, and rejoiceth as a strong man to run a race. His going forth is from the end of the heaven, and his circuit unto the ends of it; and there is nothing hid from the heat thereof."

This suggests sunrise. The powerful king of day rejoices as he steps upon the earth over the dewy mountain tops, bathing all in light and spreading gladness and deep joy before him. The lessening cloud, the kindling azure and the mountain's brow, illumined with golden streaks, mark his approach; he is encompassed with bright beams as he throws his unutterable love upon the clouds, "the beauteous robes of heaven." Soon he touches the green leaves all a-tremble with gold light. Aslant the dew-bright earth and colored air he looks in boundless majesty abroad, lightening the rocks and hills and streams that gleam from afar. From universal gloom—horribly pictured by Byron in "Darkness"—he clothes all in bright beauty, proving himself to be "of all material beings first and best." Yet the material glory is infinitely intensified when it is clothed in light by the imagination and irradiated by the poetic spirit. Over Christopher North's soul a gorgeous sunrise had ever an enchanting spell. And to the poetic mind of the philosophic genius, Prof. Ferrier, the changing colors of sunrise suggested a very apt illustration of the dark theory of the "Becoming," as laid down in mere skeleton form by the Greek philosopher Heraclitus. The dawn steals gradually over the earth and sky; and never at any moment can we say that the degree of light and color is definite and fixed. It is continually changing. It is continually becoming stronger and stronger; and yet at no instant can we say or think: here one degree of clearness or color ends, and here a higher degree of clearness or color begins. In truth, none of the changes have either any end or any beginning, so imperceptibly are they run away into each other. The reason tells the eye that, even for the shortest time that can be named or conceived, the observer never sees any abiding color, any color which truly *is*. Within the millionth part of a second the varied glory of the eastern heavens has undergone an incalculable series of mutations. The eye seems to arrest the fleeting pageant and to give it some continuance; but the reason says it is only a series of fleeting colors, no one of which *is*. As the circle is traced by a pencil moving continuously in a straight line and out of it at the same time, or as the acceleration of a falling stone is produced by the velocity being fixed and increasing at the same instant, so the gorgeous lights and colors of sunrise proceed from a blending of fixity and non-fixity. They illustrate the philosophy of the Becoming instead of the Being.

But glorious and educating and inspiring as is the sunrise in itself in many cases, there is occasionally something very remarkable that is connected with it. Rare is it, but how charming when witnessed, though till very recently it was all but unexplained. This is the *foreglow*. It is in no respects so splendid as the afterglows succeeding sunset; but because of its rarity, its beauty is enhanced. We remember a foreglow most vividly which was seen at our Strathmore Manse in January, 1893. Our bedroom window looked due west; we slept with the blind drawn. On our table was an ordinary leaf diary, with the hours of sunrise and sunset daily marked. On that morning we were struck, just after the darkness was fading away, with a slight coloring all along the western horizon. The skeleton branches of the trees stood out strangely against it. The coloring gradually increased, and the roseate hue stretched higher. The old well-known faces that we used to conjure up out of the thin blended boughs became more lifelike as the cheeks flushed. The fine old copper beech (eight feet in circumference before it breaks off into three commanding limbs), the gauzy-sprigged birches, the gnarled elms, and the holly, that alone by its green leaves showed signs of life, stood finely out against the light roseate belt of western sky. There was rare warmth on a winter morning to cheer a half despairing soul, tired out with the long hours of oil reading, and pierced to the heart by the never-ceasing rimes; yet we could not understand it. We went to the room opposite to watch the sunrise; for we had observed on the diary that the appearance of the sun would not be for a few minutes. There were streaks of light in the east above the horizon, but no color was visible. That hectic flush, slight, yet well marked, which was deepening in the western heavens, had no counterpart in the east, except the colorless light which marked the sun's near approach. As soon as the sun's rays shot up into the eastern clouds, and his orb appeared above the horizon, the western sky paled, the color left it, as if ashamed of its assumed glory. A foreglow like that we have very rarely seen; and its existence was a puzzle to us, till we studied Mr. John Aitken's explanation of the afterglows after sunset. We have never come across any of his descriptions of a foreglow, and, of course, across no explanation of the curious phenomenon. The western heavens were colored with fairly bright roseate hues, while the eastern horizon was only silvery bright before the sun rose; whereas, after the sun rose and colored the eastern hills and clouds, the western sky resumed its leaden gray and colorless appearance. Why was that? What is the explanation?

The varied phenomena attending an afterglow are capable of giving a clearer explanation of the foreglow; and to the sunset and the appearances that follow in its train we now turn. This is advisable, for during many months of the year one can witness the gorgeous afterglows, and study what we are to say in explanation; whereas it is not an easy matter to secure a good foreglow with decided varying effects. One is always struck with the resplendent brilliancy of the autumn sunsets. Some nine years ago these were exceptionally grand, and in due course something will be said about this. But for our examination of an afterglow we have selected a September day in 1893, because one could examine it more carefully with the gentler lights and colors.

A glorious sunset has always had a charm for the lover of nature's beauties. The zenith spreads its canopy of sapphire, and not a breath creeps through the rosy air. A magnificent array of clouds of numberless shapes comes smartly into view. Some, far off, are voyaging their sun-bright paths in silvery folds; others float in golden groups; some masses are embroidered with burning crimson; others are like "islands all lovely in an emerald sea." Over the glowing sky are splendid colorings. The flood of rosy light looks as if a great conflagration were below the horizon. We wended our way up to the high road between Kirrienuir and Blairgowrie to get a full view of the whole sky. The setting sun shone upon the back of certain long trailing clouds which were much nearer to the observer than a range behind; and the front of these were darkly glowing, with the fringes brilliantly golden, while the front of those behind was sparklingly bright. In the time we have taken to make these jottings the sun had disappeared over the western hills, and his place was full of spokes of living light. Looking eastward, we observed on the horizon the base of the northern limb of a beautiful rainbow, almost upright, and only a few degrees in length, produced, no doubt, by the refracted rays through the moist atmosphere in the west. Gradually it melted into thin air, and a hectic flush began to visit the eastern horizon.

Soon in the west the light faded, and piles of cold, neutral tinted cloud encanopied the semicircle of pale light. The belt of cloud above the hills, which before stood out as if brushed with liquid gold, was now chillingly dark. But out of the east there came a lovely flush, and the general sky was presently flamboyant with afterglow. The front set of clouds was darker except on the edges, the red being on the clouds behind; the horizon in the east being particularly rich with dark red hues. Ten minutes after the sun sunk, the eastern glow rose and reddened all the back clouds, but the front clouds were still gray. The effect was very fine in contrast. The fleecy clouds in the zenith became transparently light red as they stretched over to reach the silver-streaked west. But the front clouds, that were coming east by the gentle and balmy western breeze, were dark gray, without any roseate

hues. The last of the swallows were seen flying high up as if in the gauzy clouds. Close to the southern horizon there was a deep hand of red unclouded sky, against which the wooded Sidlaws looked hlack and somber. The new moon was just appearing upright against a slightly less bright opening in the sky, which, with the shriil cry of an owl in the copse, had a mystic effect on the scene. In five minutes more the rosy coloring left the eastern horizon; hut, when the clouds opened in the west, the flushed sky was then magically displayed. Again, in the north, east, and south a richly roseate helt was marked between 50° and 10° of elevation. Gradually the back clouds in the zenith (very thin) hecame slightly reddened, hut the front clouds then were uncolored as before. As the coloring of the upper zenith clouds wandered to the west, where a flush of glowing was seen in the hack clouds, the red in the east gradually waned. The varying shades of the different kinds of hlue were now beautifully seen from the pale blue at the horizon to the deep azure of the zenith. Half an hour after sunset there was no red in any part except a lingering flush in the sky hehind the western clouds. But, strange to say, within the next ten minutes a second glow commenced, very feeble, still discernihle. The north and east warmed up slightly with a slight tinge of rosy red. Gradually the under clouds, ahout 50° above the western horizon, became slightly red heneath, the hack ones being dark—the reverse of what was seen before. Fifty minutes after sunset the east was still slightly flushed, as was part of the open sky in the west, whereas the open sky in the southwest was of a pale bluish-green hue. Soon the colors collapsed, and the peaceful reign of the later twilight possessed the land. The temperature was 58° Fahr., far too high for a gorgeous display. (This will be afterward explained.) The grass was perfectly dry, and there were no symptoms of dew, also against hrilliancy in the afterglow.

Now why was the eastern horizon so flushed with crimson when the sun had sunk in the west, and silvery light alone was seen in the opening of the sky above where the sun had disappeared? Similarly, why was it that in the foreglow that belted the western horizon there was a rich roseate color, while in the east, before sunrise, there were only light silvery streaks that indicated the sun's approach? Why should there he red colors in the least expected places —especially such an immense variety and wealth of reds? Mr. John Aitkin, F.R.S., has devoted considerahle attention to this subject, both in this country and in the south of France. What we cannot so easily determine here, where the skies are so generally cloudy, and the temperature so variahle, he easily discovered in sunny France; for there the different sunset effects repeat themselves evening after evening in cloudless skies and with equable climate.

Some are of opinion that the varied colors are due to an excess of water vapor in the atmosphere, the sun's rays being colored as they pass through the vapor. But he is of opinion that, though moisture in the form of vapor particles (formed hy the dust particles attracting the moisture in the air) increases and intensifies the colors, yet atmospheric dust is essential for the production of the afterglows. And he was the more convinced of this hy the very remarkable and heautiful sunsets which occurred ten years ago, after the tremendous eruption at Krakatoa, in the Straits of Sunda. There was then ejected an enormous quantity of fine dust. Mr. Verbreek, a high authority on the subject, computed that no less than 70,000 cubic yards of dust actually fell round the volcano itself. This will give an idea of the enormous quantity of fine dust that was showered into the atmosphere all over the world. So long as that vast amount of dust remained in the air did the sunsets and afterglows display an exceptional wealth of coloring. All observers were struck with the vividly hrilliant red colors in all shades and tints. Now, if dust is the cause of these glowing colors, there must he somewhere the blue complementary coloring, seeing that the dust acts as a disperser and not an absorher of the sun's component rays. The minute particles of dust in the atmosphere arrest the rays and scatter them in all directions; they are so small, however, that they cannot arrest and scatter all; their power is limited to the perfecting of the rays at the hlue end of the spectrum, while the red rays pass on unarrested. There, therefore, ought to he somewhere in the sky a display of the colors of the blue end of the spectrum; and these are found in numherless shades from the full hlue in the zenith to the greenish hlue near the horizon. In fact, the wonderful greenness sometimes appears in a clear space in the lower sky, more intensified when contrasted with a rose-colored cloud or haze alongside of it. Dust, then, is the main cause of the glowing colors attending sunset; for none of the colors are destroyed—only sifted out and sorted in a marvelous way. If there were no fine particles of dust in the upper strata, the sunset effect would he whiter; if there were no large particles of dust, there would be no coloring at all. If there were no dust particles in the air, the light would simply pass through into space without revealing itself, and the moment the sun disappeared there would be total darkness, as when a candle is blown out in moonless midnight. The very existence of our twilight depends on the dust in the air, and its length depends on the amount and extent of the dust particles.

We saw that soon after sunset, though the western sky was silvery, the sky near the eastern horizon was flushed with red. That is due to the sun's rays heing deprived of all except the red in their passage horizontally through so much of the atmosphere, and these red rays falling on the large particles low down in the eastern heavens illuminated them with red light. This red light near the eastern horizon would he much redder if it were not for the great amount of hlue light reflected by the particles from the sky overhead. But how have the particles been increased in size in the east? Because, as the sun was sinking, but before its rays failed to illumine the heavens, the temperature of the air hegan to fall. This cooling made the dust particles seize the water vapor to form fog particles of a larger size. The particles in the east first lose the sun's heat, and first hecome cool; and the rays of light are then hest sifted, producing a more distinct and darker red. As the sun dipped lower the particles overhead became a turn larger, and thereby better reflected the red rays. Accordingly the roseate bands in the east spread over to the zenith and passed over to the west, producing in a few minutes a universal transformation glow. Before, however, the ruddy flush reaches the zenith, the polariscope could display the redness even then, though unseen by the unassisted eye. From this we see that the crimson, seen in the east shortly after sunset, ascends in gradually paling hues, by reason of the interference of the strong deep hlue overhead, then stretches overhead on to the west, where again it hecomes more golden, mixed in an aurora-like glow.

The variety in the colors and the difference of their intensity depend, too, upon the two sets of dust particles in the air. To produce the full effect often witnessed, there must be, besides the ordinary dust particles, small crystals floating in the air, which increase the reflection from their surfaces. These crystals shine far more hrilliantly when suspended in the air between the observer and the sun than in any other position, and there is generally a sufficient numher to produce this glorious result. The light reflected by the large quantities of ordinary kinds of dust is the chief cause of the red glow in the south, north and east; the crystals enhance the western glow effects. In winter sunsets, the winter-clad dust particles get frozen, and the red light streams with rare hrilliancy, causing all reddish and colored objects to glow with a strange hrightness. Dead beech leaves, which in ordinary are not noticed in a marked degree, shine out as deeply red as those of the hlood-stained maple. All the red tiled roofs or red sandstone gables of the houses shine out brightly, as if painted with vermilion. When afterward we find that there has been a heavy deposit of dew, we can account, by the sudden change of temperature after sunset, for some of the hrilliancy of the coloring; then the air glows with a strange light as of the northern dawn. From all this it is clear that though the coloring of sunset is produced hy the direct rays of the sun, the afterglow is produced hy reflection or rather radiation from the illuminated particles near the horizon.

But we can satisfy ourselves still more hy another consideration that the afterglow is only a reflection of the sunset colors on the horizon hy the same particles as shown hy the direct sunlight before. Every one knows that daylight is far hrighter than lamplight, yet it is not so easy to realize the full difference. Bring a lighted lamp into the room about sunset, without drawing down the window blind. The room does not seem to he any better lighted. One experiment was made where the window looked to the west. As the sun sinks, note how the lamp begins to light up a wider and wider area in the room, until the room seems lighted hy the lamp alone, while we can still see our way ahout in the lawn outside. Similarly, if we keep in view the vast scale of brilliancy to he met with at sunset, we can see that what is dark at one time and under certain conditions may really appear brilliantly illuminated a short time afterward under different conditions. If a small area of the brilliantly clear western sky were projected hy means of a mirror upon the eastern, the eastern, which looked bright hefore, would, alongside the reflection of the western, look hlack. A cloud on a bright sky may look hlack; but remove the white sky, and we find the cloud is brilliantly lighted up. No red glow is observed overhead by the naked eye, while the polariscope can detect it, so that the red must he there. When conditions change, the red becomes visihle. We imagine that in the afterglow the red overhead has increased; but in reality it has decreased, for the stars are hecoming more and more numerous, showing that the daylight has been decreasing all the time.

To keep the eye from being bewildered with the afterglow, let the setting sun shine into your room so as to paint an image of the window on the wall opposite. A bright orange light may be ohserved in the picture, while the little clouds in it are lighted up with the same hue. As the sun sinks, the color deepens in the picture, and the clouds then glow with a fine red light. After the sun ceases to shine on the clouds, their hrilliancy gradually wanes, until at last they appear to he black; yet if you look out, you will find the sky in the east and overhead flushing with crimson. After a time, the clouds in the picture lose their hlack appearance, and their western edges again glow with a rich light, very much as at first, except that the sharp outlines have hecome hazy. This shows that the illumination was from the western sky, as the clouds were far too low to be lighted up by the direct rays of the sun. The hazy outlines, too, give evidence of the indirect light which illuminates them.

Without the dust particles there would be no foreglows or afterglows—no dawn, no twilight. Sudden light and sudden darkness would daily startle man and beast. There would be no coloring either in the morning or evening. The charms of sunrise and sunset would he gone. Strange that the grandeur of the heavens in sunrise foreglows and sunset afterglows depends for its existence on dust particles and water vapor!

It has long been supposed that the coloring of earth and sky at sunrise and sunset is more gorgeous when observed from the top of a mountain than at its hase; hut Mr. Aitken's careful and repeated ohservations at the Rigi Kulm (6,000 feet), in Switzerland, fall point the other way. For several days he took accurate notes of the ohservations, and the weather was uniformly favorable; but on none of the days did he see any display of color; indeed, he was particularly struck with the want of it. Grays predominated over other colors. Now during that time, he was afterward told by trustworthy observers, the sunsets a mile below, from Lucerne, were remarkably fine for color effects. The coloring must, therefore, have heen produced hy the more dusty lower air. This supposition is supported hy other observations. On the mountain top the near cumulus clouds were always snowy white, while it was only the distant ones that were tarnished yellow, showing that it required a great distance at that elevation to give even a slight coloring. There seems, therefore, to he very good reasons for supposing that the coloring at sunrise and sunset will he more brilliant when seen from the valley than from the mountain top.

We cannot help lingering fondly on this charming suhject, just as the sun lingers in the production of the afterglows instead of suddenly finishing its work. We have to witness the sunsets at Ballahulish to be assured that Waller Paton really imitated nature in the characteristic bronze tints of his richly painted landscapes; and never can we forget the May afterglows at Bridge-of-Allan, where, recruiting after a long illness, we were spellhound hy their fresh and invigorating grandeur. Then, of course, we were more susceptible to the magical power of Nature. The air was full of music. The thrush rivaled all the songsters of the grove in pouring forth, in his varied movements, his passionate love song. Oh, for the power of Richard Jefferies to put in words what we saw and felt! The trees were heing clothed with their fresh foliage; the green heing unscorched, the brown heing unbronzed. Peace reigned supreme, and Nature reposed in rosy sleep. The full moon was shining in the east with horrowed, reflected light, for already the sun was below the horizon. The clouds were tinged with light red from the eastern horizon all over the zenith, hut in the west they had more of a neutral tint; while helow the rich, roseate, fairy-like light clothed all the trees with a golden sheen. And behind all there seemed to be manifested a Spirit to which our own spirit thrilled in ecstasy. Such a scene of glory must elevate the moral tone of any man who is not soulless. The conception of the Divine rises ahove the material phenomena to purify, to hallow, and to calm the human spirit. Then we discern that science hecomes possessed of heavenly light, and "by that light really see light."

Nature's self, which is the hreath of God,
Or His pure word by miracle revealed.

—*Gentleman's Magazine.*


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## MACHINERY FOR CHARGING AND DRAWING GAS RETORTS.

THE most recent installation of Mr. John West's improved machinery for charging and drawing gas retorts was completed about six months ago by the West Gas Improvement Company for the Bradford Road Gas Works of the Manchester corporation. For our illustrations and the following particulars we are indebted to the *Engineer*, London. At these gas works the retort house is of the stage floor type, and has 28 beds of 24 in. by 16 in. D retorts, 20 ft. through, some beds having 8 retorts and some 9 in a setting. Before the machinery was put in operation some of the retorts were worked by manual labor on the old system of stoking, and the stokers charged each retort with from 3¼ cwt. to 3½ cwt. of coal per mouthpiece, or from 6½ cwt. to 7 cwt. per retort, and this amount was carbonized in 4 hours 48 minutes. The machinery has been designed for putting in at least 4 cwt. of coal per mouthpiece, or 8 cwt. per retort every 4 hours 48 minutes, and this amount is now being regularly charged. It is found in practice that when the coal is properly and evenly distributed in the retort, a considerably greater weight of coal can be carbonized in the same retorts in a given time.

From the fact that with machinery the coal is broken to a regular size, and is evenly charged throughout the length of the retort by the chargers, it arises that a greater quantity of coal can be carbonized per retort than is the case with ordinary hand labor. In this case the retorts are heated by a good system of regenerative firing, and there is no difficulty in attaining the heat for properly carbonizing the coal. The hot coke is drawn direct from the retorts into the furnaces by the drawing machine, or into wagons below the stage floor.

Since the machinery was first started on December 8 everything has gone on smoothly, and the men have learned to work it very quickly, proving that it is easily manipulated and simple in action. The whole plant is being worked as regards cost in accordance with a schedule submitted at the time of acceptance of the tender. In West's system the whole of the manipulation of the coal, from the time when it is delivered out of the railway wagons on the overhead railway in the coal stores until it is deposited as coke in the wagons below the stage floor, ready for removal to the coke yard, is done by machinery, without more manual labor than is necessary for attending to and working the machines. Four large cannel breakers are placed in the coal stores, two on each side of the retort house. Each breaker is independent of the others and is worked by a separate steam engine, and they have been designed to meet the requirements of the Bradford Road Works, where the cannel and coal consists chiefly of very large pieces, which have to be broken smaller before being placed in the retorts. The shafts, claws and gear have been made of steel throughout of very strong sections and massive proportions. These cannel breakers are the most powerful that have been constructed for gas works, and will break the largest and hardest cannel to a suitable size. The breakers are erected in pits below the floor line and are covered with iron flooring, supported by girders, and each floor has a door in it to allow of access from the retort house.

When the cannel or coal has been reduced to a suitable size by passing through the breakers, it falls, with smaller pieces which have not required to be broken, into the bottom of the pit, and round the bottom of the elevator, which runs in the pit, and then, by means of the buckets of the elevator, it is carried up to a large overhead hopper in the retort house. The elevators are constructed of strong detachable elevator chain and iron buckets, fitted with guides for sliding up and down a strong steel lattice framing, and they are driven from the cannel breakers by means of belts and chain gear. There are four overhead storage hoppers in the retort house, each constructed of steel plates and angles and supported by strong girders spanning from the outside walls to the retort stack. Each hopper is provided with two outlet doors at the bottom, which are opened or closed by hand levers fixed near the walls. The hoppers are placed at convenient positions in the retort house for the charging machine to pass under and take a supply of coals.

The charging machines are fitted with propelling gear for traveling up and down the retort house on rails laid parallel with the retort stack. Each machine carries a supply of coal in an adjustable hopper, supported by chains from the top of the frame, and the hopper can be raised or lowered to suit the various tiers of retorts by means of gearing worked by the same motor that propels the machine. The hopper on each machine for carrying the supply of coal for the charging is provided with a feeder box controlled by a hand wheel for regulating the amount of the charge. The charger which enters the retort with the coal is carried in a frame suspended below the hopper, and is driven in and out of the retort by a compressed air cylinder, rack and pinion, chain drums and chains. This

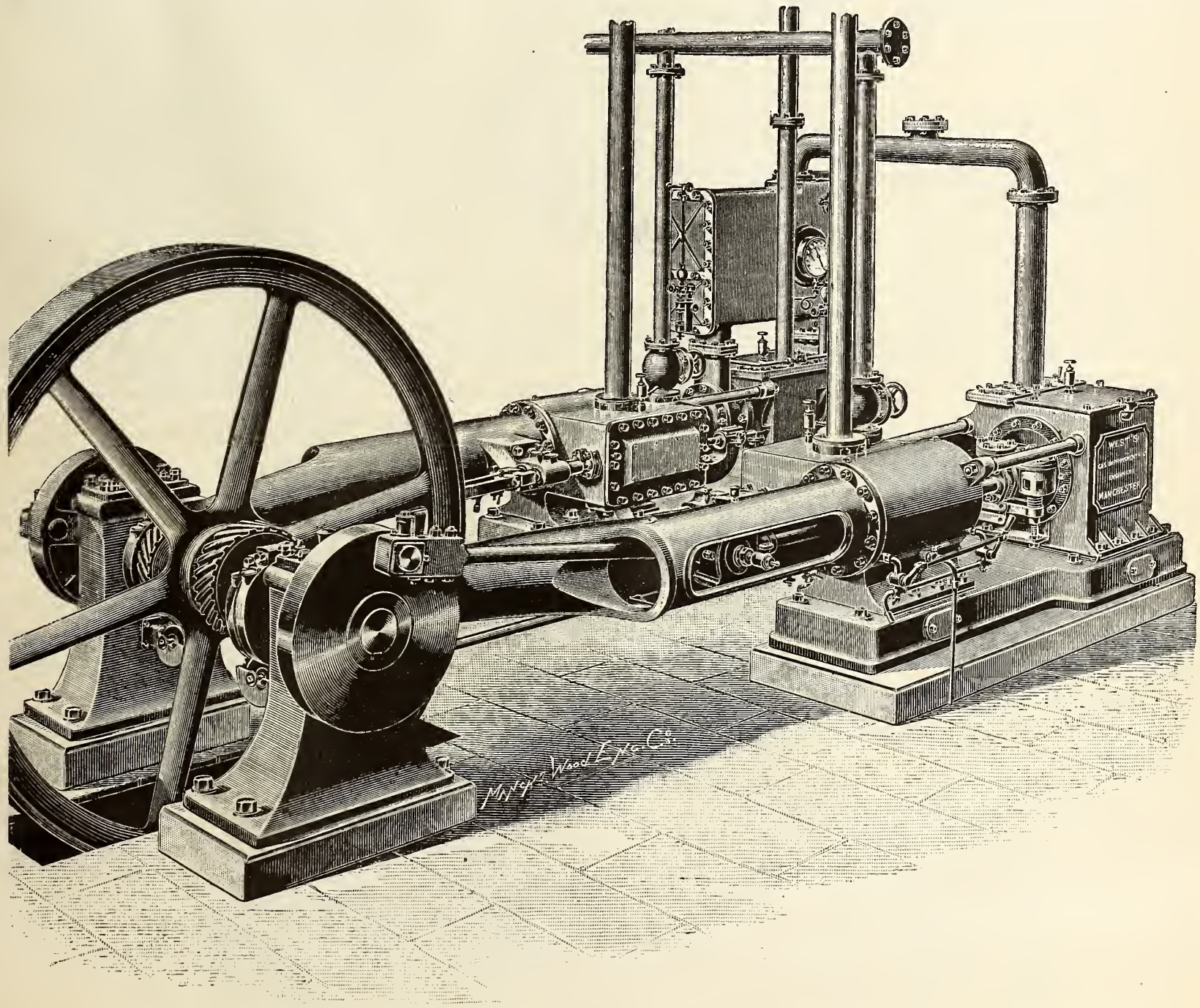


FIG. 1.—AIR COMPRESSOR, MANCHESTER GAS WORKS.

charger, which is a very important part of the apparatus, has all the movements for charging a retort properly, the mechanism being protected from the coal dust by a cover. The charger consists of a scoop and a carriage containing the mechanism for emptying the coal out of the scoop and righting it for a fresh supply. It is also arranged that the scoop shall enter the retort twice in order to make a complete charge, first turning over in one direction and next in the other, thus throwing the coal toward the right and left hand sides of the retort respectively. The scoop is entirely suspended by its carriage, and does not at any time rest on the retort.

The drawing machines are fitted with traveling gear and hoisting gear for raising and lowering the rake bar frame, carrying the rake bar and head to the several tiers of retorts. It is fitted with compressed air and controlling cylinders, rack and pinion, chain drums and chains for driving the rake head in and out of the retort. Both the charging and drawing machines are worked by compressed air, supplied by an air compressor fixed in a building at the end of the coal stores. This compressor has many special features for compressing air with the smallest possible expenditure of steam. The cylinders are steam jacketed and fitted with expansion valves, with variable cut-off, adjustable by hand from the outside. All the bearings are of extra size, to minimize wear and tear and repairs, under the conditions for running day and night. The air cylinders are of two sizes, and do the work of compression to 60 lb. per square inch in two stages; and between the cylinders there is a tubular cooler to take out the heat developed by the compression in the low pressure cylinder. In addition to this, each cylinder is provided with a jacket filled with water for cooling. The suction and delivery valves have a positive action controlled by cams on revolving shafts, so that the valves may have large areas and wide openings to prevent wire drawing and friction of the air and yet be well under control to prevent detrimental shocks.

Fig. 1 shows a general view of this compressor, which has been arranged of sufficient size to drive six pairs of the machines, and a perspective view of the air cylinders with their valve mechanism is shown Fig. 2. Having perceived that no defect has had such a prejudicial effect upon the working of compressors as the throttling of the inflow and outflow passages due to insufficient valve area, and that it was hopeless to expect better results from automatic acting valves of any description, it was decided to arrange them with a positive action, and thus to control both the closing and opening periods of their operation. This object is achieved by Messrs. West and Jenkins' patent arrangement in the following way: Springs are arranged upon the valve stems in such a manner that the weaker or opening spring has a tendency to open the valve, while the stronger or closing spring tends to close it. The latter spring is raised and released by means of levers worked by revolving cams. For instance, the operation of a suction valve is as follows: During the latter part of a given compression stroke, the cam is arranged to depress one end of the lever and compress the closing spring, thus leaving the valve closed under the pressure existing in the cylinder, but having a tendency—given by the opening spring—to open. As soon as the piston recedes, the pressure above the valve is reduced, and the opening spring immediately lifts it wide open, the amount of the lift being such as to give a free area equal to the area of the seating. The cam then keeps the closing spring compressed during the greater part of the suction stroke, and the releasing of the spring only begins when the piston is two or three inches from the end of its stroke; the springs then gradually force the valve shut as fast as the shape of the cams will allow, the valves thus closing very slowly, and all hammering is entirely prevented. The motor, which is shown in Fig. 3, consists of a double cylinder engine boxed in so that the whole of the working parts run in an oil bath, the reversing being done by Joy's patent valve gear.

After the air is compressed it is delivered into and is stored in two cylindrical receivers placed in the coal stores. These receivers are provided with all the necessary inlet and outlet connections and safety valves. The air is conveyed from the receivers by iron pipes to the hose drum fitted to the girders carrying the overhead coal hoppers for supplying the charging machine with coal.

There is a large hose drum complete with all fittings for each of the charging and drawing machines, a long length of flexible hose being attached to each of these drums at one end, and at the other end to the machine which is supplied from it. Each drum is provided with a hollow shaft through which the air is supplied, and by an arrangement of gun-metal swivel joints, the air is supplied to the hose on the drums while they revolve. On each of the hose drum shafts a chain drum is keyed; a chain attached to this leads over pulleys fixed in the retort house roof, having weights at the other end, which rise and fall as the hose is automatically paid out and in by the machines. The hose leading from the drums of the machine is specially constructed for conveying air, and is supported at intervals by suspending brackets and rollers, so that the strain on the hose is very light.

As regards the financial results of the system, it may be interesting to state that, prior to the use of the machinery, 100 men were employed per twenty-four hours in the retort house, and since that time the total number is 67, a reduction of 33. In both cases the number given includes every kind of labor required in the retort house and coal store—stokers, coalmen, cokemen, and furnacemen in one case, and the machine attendants, engine drivers, stokers, cokemen, and furnacemen in the other. The men dispensed with are principally the high paid stokers who work close up to the hot retorts; and, according to Mr. Geo. Livesey's evidence before the Royal Commission on labor, the proportion of this particular class dispensed with is no less than 61 per cent. of the number employed before the introduction of quantities of similar machinery by the same makers at the South Metropolitan Gas Company's works in London. The total cost by hand labor amounted to 2*s.* 5*d.* per ton of coal carbonized, and by machinery the cost of labor is 11¼*d.* per ton, to which must be added the ascertained cost of fuel, oil, waste, wear and tear, depreciation, and interest on capital outlay, amounting to 3*d.* per ton, or a gross total of 1*s.* 2¼*d.* per ton, leaving a net saving in favor of the machine work of 1*s.* 2¾*d.* per ton. The amount of coal carbonized per annum is about 105,000 tons.

## ARTIFICIAL FUEL GAS.

By HENRY WURTZ, Ph.D.

WRITERS in general literature often urge that man—to gain his ends and to discover the best means of their attainment—should ever aim to follow and imitate Nature; searching out first what she does and how she does it. This precept, plausible as it is, very rarely has any practical application to the great arts of civilization, in which man must continually strive to advance, to better himself, if possible, and certainly his race.

The impersonality called Nature works and has worked under conditions usually unattainable by man—a remark that applies to her modes of elaboration of the most valuable substances she presents to us. She has had materials, time and energy without limit. For man all these are narrowly limited. The valuable products of Nature referred to have almost all been accumulated with extreme slowness by processes impossible in human practice.

This statement applies eminently to combustible gas, now so great and so growing a factor in the affairs of civilized life. Nature presents to us almost pure gaseous *methane* (marsh gas, fire damp, or "natural gas"), in quantities incalculable; while to man the preparation of this special gas artificially in isolated form is so difficult that as yet it is but a curiosity of the laboratory. Nevertheless, as it often happens with popular fallacies that there is some tincture of truth in them, there are here hints of value to man in Nature's mode of storage of her fire gas under great *pressure*.

Man, unable to get methane in quantity by any artifice as yet discovered, has been compelled to diverge widely in this field from Nature's track. To find a cheap, incondensable, smokeless, gaseous combustible, as a vehicle of heat energy, he has been obliged to resort to what is popularly known as "water gas." This consists practically in a solution of carbon by high heat in steam. It ought to be called *steam-carbon* gas. The name water gas has done mischief by imbuing the minds of many with the fallacy that water could be converted *per se* into a combustible. In so-called water gas there is no water, as such. It is partly composed of the elementary basis of water, *hydrogen*, the rest being mainly *carbon monoxide* (carbonic oxide), the same gas that is often seen burning with a bluish flame over an anthracite fire, sometimes called "stove gas." It often escapes from open stoves, always injuriously, and sometimes with fatal effects. It contains all the oxygen of the steam, but can burn with just as much more oxygen, to form carbon dioxide (carbonic acid). By weight it contains, roundly, 3 of carbon to 4 of oxygen; or, in 100 lb., 43 carbon and 57 oxygen. When it burns, that is, doubles its dose of oxygen, the carbon dioxide formed contains 3 of carbon to 8 of oxygen; therefore, in 100 lb., 27·3 carbon and 72·7 oxygen. Carbon dioxide is well known as the gas of fermentation, contained in beer, champagne, effervescent "mineral waters," etc. It also can suffocate or asphyxiate (as often in wells and caves), and is rated by many toxicologists as a narcotic poison, but is doubtless less dangerous than carbon monoxide. Curiously, in the stomach it is even beneficial, being merely a mild sedative.

Neither of the main constituents of water gas (hydrogen and carbon monoxide) are found at all plentifully in nature, and have certainly never been stored up for man, like methane.

If steam be passed into highly heated *pure* carbon, 9 lb. of steam with 6 lb. of carbon form 1 lb. of hydrogen and 14 lb. of carbon monoxide. By a wonderful chemical law, the resulting water gas contains exactly *equal volumes* of the two mixed gases—carbonic oxide being exactly fourteen times as heavy as hydrogen—the former (sp. grav. = 0·97) having almost the weight of air, while air is 14·43 times the weight of hydrogen (sp. grav. = 0·0693).

$$\text{Thus: } \frac{1}{0{\cdot}0693} = 14{\cdot}43\text{; and } \frac{0{\cdot}97}{0{\cdot}0693} = 14{\cdot}0.$$

This simple relation is, however, *never found* in practice. Deficiency of heat leads to the formation of some carbon dioxide with some of the oxygen of the water; and there are always present, in both anthracite and coke, some iron and sulphur, both of which take up oxygen and set free hydrogen. There is also a small percentage of hydrogen, contained in the coal or coke, set free. Through these joint influences, the hydrogen always predominates in practice over the carbonic oxide, sometimes 15 per cent. or more in volume. It is important to note this, for it is singular how many writers have committed the oversight of assigning to water gas, as practically made from coal and steam, the *theoretical* equality of volume between the two components. Even so high an authority as Dr. Bunte, the eminent German gas expert, seems to have sanctioned this error. As another example, W. J. Taylor, in an elaborate communication to the Institute of Mining Engineers in 1890, introduces the same inaccuracy more than once, and, himself misled thereby, ciphers out thence the weight of 1,000 cubic feet of what he gives as a *typical* water gas = 45·6 lb., quite 10 lb. too high, thus vitiating largely his conclusions. He also states that 1,000 ft. consume in production 48 lb. of anthracite, some 27 per cent. too high. Besides its two main components, water gas always contains a small percentage of marsh gas (methane), which is by no means unimportant, and a little nitrogen, which is of trifling importance.

The history, during a century past, of the art of producing water gas can occupy but a very limited space. There appear first two of what may be called traditions. One carries it back just a century, to Lavoisier, in 1793, the year before he was murderously done to death by the guillotine. When he asked, on his way to execution (in vain) for a day's respite, to enable him to record an invention valuable to his fellow men, he is thought by some to have meant water gas. The other tradition goes back to Felice Fontana, 1780, a year previous to the first synthetical discovery of the composition of water by Cavendish and others. It is probably only fanciful. The first actual record of the passage of steam into incandescent carbon to make gas is in the British patent to John Holt Ibbetson, seventy years since, in 1824. Many have thought that one of the most important features of our present water gas method, that of alternation of air and steam, is implied in the British patent of 1852 to the Kirkmans; but careful examination shows that, if implied, it is too vaguely specified to be satisfactory. The Kirkman patent does, however, plainly cover two important features—one the making of the steam by the waste gases from the air blast, the other the subsequent passage of these same waste gases through metal tubes, around which the air passes that is blown in. This is a kind of recuperator anticipating that of Siemens. It is not till the French patent of 1860 to Fages that we find distinctly the method of alternating blasts of air and steam specified, as now universally practiced. In the mean time, so-called "producer gas," or air-steam gas, as it is best called, had been invented by another Frenchman, George Michiels, then in the island of Guadeloupe. His patents, both American and British (the latter as a communication to John Constable), are dated on the same day, May 24, 1845.

The further combination of "checker-work" regenerators—as introduced in 1856 into metallurgical furnaces by Siemens—originated in America about 1874, simultaneously with T. C. S. Lowe and Myron H. Strong (deceased). This feature was made to perform quite different functions, however, by these two inventors. The aim of Strong was to make water gas, or *fuel* gas pure and simple, for heat and power, and he used his checker-work to carry back with the steam blast the heat generated by burning in it the gases from the air blast. Lowe aimed at a compound *illuminating* gas—introducing oil or naphtha into his hot water gas, and passing the mixture through the checker-work, previously made incandescent by burning through it, with more air, the gases from the air blast. The object of this was to "fix," or permanently gasify, the oil vapors. It is this latter method that has already, in twenty years, come so extensively into use and spread over this continent, for making illuminating gas. Few inventions have had a career so immense and so rapid; though obliged to encounter the competition, or rather (what was worse) the prejudices, of opulent "vested interests," already in secure possession of the whole field, banded together to resist all innovation from outside, and with whom a novel experiment, on the part of an employe, was usually equivalent to dismissal. The general principle was here exemplified, that leading inventions in special arts scarce ever originate among the specialists engaged in operating such arts; but are commonly forced in from outside by men who, not being specialists, are not held in a rut, but are at liberty to seek out and explore better paths. On this subject controversies arose during the decade from 1875 to 1885, full of the most extraordinary bitterness, acrimony, misrepresentation and even persecution—not much surpassed in the religious wars we read of in history. Most of this must be passed over here. In 1880, the present writer made an extended communication to the Institute of Mining Engineers on water gas, in which all the accusations brought against it were rebutted, and the opposition of the gas profession thereafter greatly enfeebled.

Although, as will be apparent, the methods and the results of Strong and Lowe differed essentially, yet, as their combinations of apparatus were similar, they were at once plunged in the Slough of Despond called an "interference." Had not moderate counsels prevailed within two or three years, this might have proved the finality. The present writer, who was called in professionally by parties interested with both inventors, urged without ceasing a policy of compromise, which ultimately prevailed.

The accusations brought against the use of water gas alone or in combination with illuminants, which originated among the gas profession, but were adopted and advocated by most of the men of science of this country, and by the scientific journals generally, may be stated as follows: By the laws of combustion and dissociation water gas must needs cost as much to get it as can be got from it; that is, to *unburn* water must take as much heat as the resulting hydrogen can evolve in burning again; water gas is loaded with one of the most *terrible and fatal of poisons;* its odor was not such as would alarm consumers, and hence gas deaths and explosions would quickly decimate and desolate the land; it was so dense that it would not pass the mains and service pipes, and would stratify on the floors of rooms; it was terribly explosive and incendiary; it was easily condensed; it required new and special burners; its manufacture was dependent on anthracite, and, for an illuminant, on oil, local and precarious materials; no coke was made; the tar formed was worthless; it was impossible to purify out the sulphur from it; it involved danger from storage of oil at the works, and so on. Each of these arguments was found in practice to be incorrect, or without weight. That which appeared the most serious of all, and which even to this day is insisted on largely by some men of science, is that of the very poisonous nature of carbonic oxide. It was claimed that more than 10 per cent. of this component should taboo a gas altogether for domestic uses, and State laws were even passed to enforce this restriction. These were soon repealed; in Massachusetts the very man who originated the law petitioning for its repeal. Many of the men of science who fought, and still fight, against water gas, ignore what they should know well, that certain other illuminating gases that have been and still are largely in use contain much more than 10 per cent. of the "deadly poison," thus: Gas from Ince Hall cannel, 10 per cent.; from Lesmahago cannel, 15 per cent.; animal oil gas, 15½ per cent.; resin gas, 19 per cent.; peat gas, 20 per cent.; and wood gases from 26 to 41 per cent. At the present time the vast majority of the American gas profession have bravely overcome these prejudices, and now more than half, some maintain full two-thirds, of the illuminating gas on this continent is made by the Lowe process or modifications thereof.

The Lowe process was launched at a most fortunate period, and enjoyed great advantages to compensate for the virulent opposition met from several sources, as already related. It was an improvement in the production of an article of human consumption and necessity, having already a large *established market.* The public required little or no *educating* into it, as it does

in the case of most novel inventions. It had, indeed, long demanded improvements in this field, and recognized them at sight. Holders and mains, etc., for storage and distribution, were already at hand. Oil was abundant and increasingly so. Intelligent and disinterested men rarely paid much attention to the accusations above mentioned, knowing, as most men now know, that in most arts the men who should be the first to seek for improvements are often the last to admit or even consider them, because they *interfere with established routine*. But, above all, it was found in time by the manufacturers themselves that one great virtue of the Lowe process was its *rapidity;* which is many times as great as the old methods with gas coals and retorts. Even those of the gas profession who could not and do not yet abandon their *religious* reverence for the time-honored gas retort now want a water gas generator in their works, as a supplementary provision for emergencies, when their gas holders have sunk alarmingly low. A few hours' work then with the generator lifts them to the top of the framework again. Then, as the retorts burn out, they are irreverently cast aside, and the genera tor ultimately rules supreme. The Strong process, though the writer believes it destined ultimately to even a greater career than that of Lowe, has had no such advantages. Natural gas has, it is true, educated such communities as are fortunate enough to be within its boundaries of distribution into the immense value of gaseous fuel; but doubtless a vast majority of the people of this continent have never had such "object lessons," and have never even seen natural gas burn. There is yet no *market* ready made anywhere for fuel gas, and, above all, no storage or distribution systems everywhere available, as in the case of the Lowe gas. Our college professors have not yet overcome their horror of carbonic oxide, and still teach it to their pupils. All men of science do not adhere, however, to these prejudices. Two paragraphs may here be cited, to contrast the animus formerly prevalent with that of one of the great chemists of the present age, or indeed of any age. The first is from the Boston *Journal of Chemistry*, which was in its day a most estimable and reliable journal in general. June 1, 1881, the following editorial passage is found in it:

"Frauds of a higher type in the line of invention are often brought to notice, and just now many of this kind are prominent. To this class belong the 'Keely motor,' the 'water gas' delusions, and so on. With the 'respectable' fallacies we are also inclined to class Edison's scheme of electric lighting by incandescence"!

The "fallacies" of the writer of this need no explanatory remarks at the present day.

The second passage is from Mendeleeff's great work, "The Principles of Chemistry," published just ten years later than the above, in 1891, by Longmans, Green & Co., London. On page 390, vol. 1, we find as follows, on water gas:

After stating that "it is available not only for domestic and industrial uses, but also for gas motors and for lighting" (instancing various forms of incandescent gas lights, from Crookshanks and Gillard down to Fahnehjelm and Von Welsbach; also compound enriched gases, and the uses of naphthalene, benzole, etc., with it), he goes on to say:

"As water gas, possessing these properties, may be

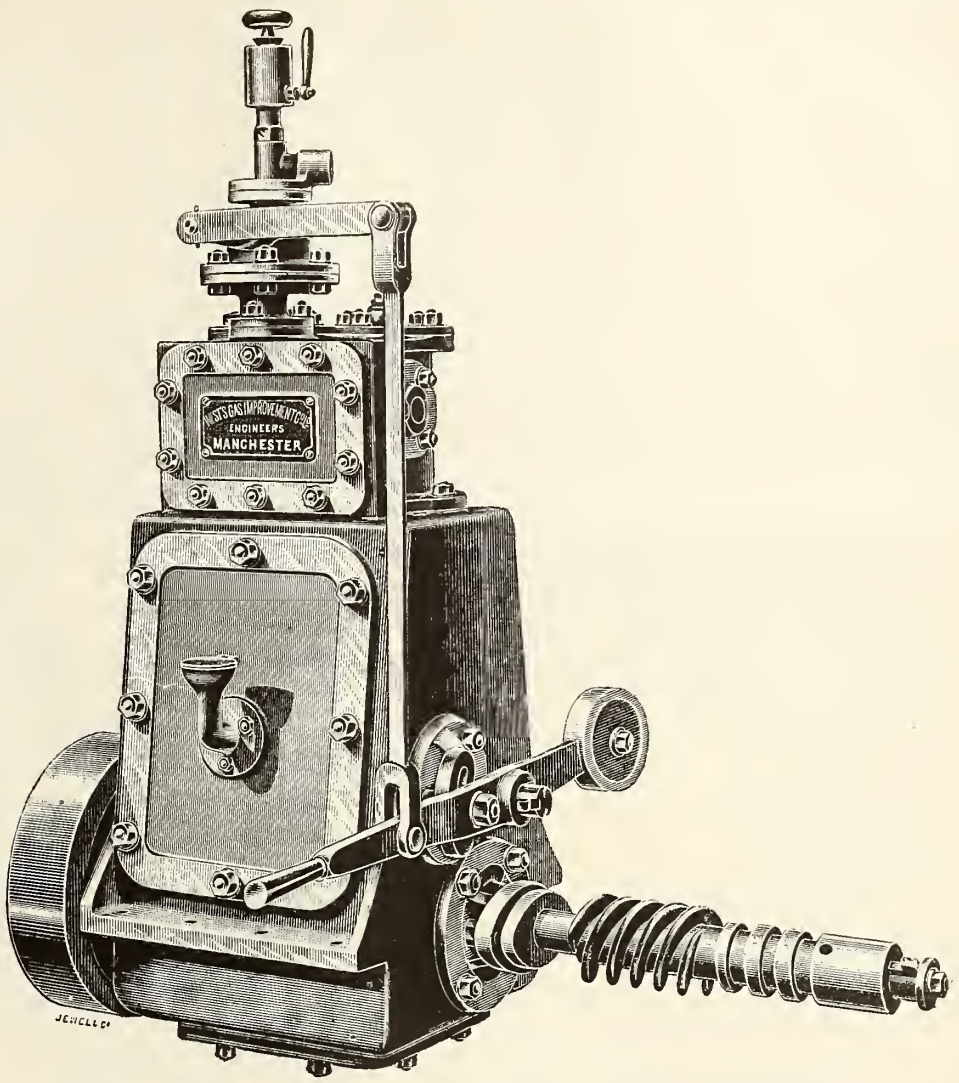



FIG. 3.—THE MOTOR.

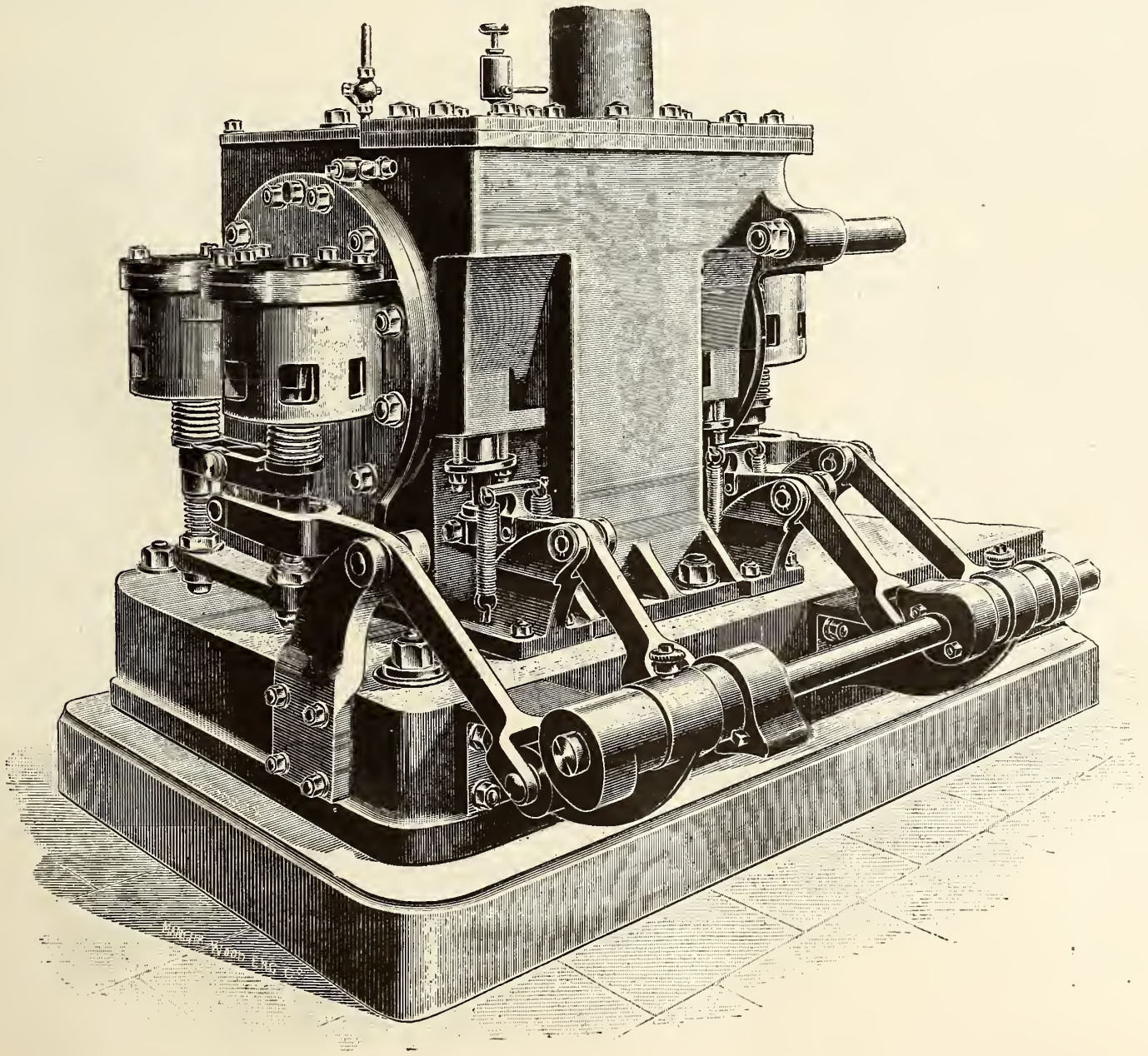


FIG. 2.—VALVE GEAR OF COMPRESSOR, MANCHESTER GAS WORKS.

prepared at central works and conveyed in pipes to the consumers, may be produced from any kind of fuel, and ought to be much cheaper than ordinary gas (he means, of course, gas from gas coal), it may actually be considered that in the course of time (when practice shall have determined the best and cheapest way to prepare it) it will not only supplant ordinary gas, but will, with advantage, everywhere replace the ordinary forms of fuel, which in many respects are inconvenient. At present its consumption spreads principally for lighting purposes, and for use in gas engines, instead of ordinary illuminating gas." It will be observed that Mendeleeff does not mingle with the carbonic oxide imbroglio.

The writer has now arrived at the stage of our subject at which to introduce his proposed plans of utilizing pure water gas, so as to realize the expectations he has himself already set forth, and which, as has been seen, are entertained also by chemists of such rank as the illustrious Mendeleeff. Gas for fuel and power purposes, when once fairly introduced into public use and favor, will rapidly create for itself a market surpassing in magnitude that for illuminating gas to an enormous extent. Such market must indeed grow to such a magnitude that the ordinary modes of storage and distribution will be wholly inadequate, and new engineering problems will at once arise. The primary solution of this difficulty is set forth in an early paragraph of this essay, namely, storage and distribution in a high state of compression, just as nature supplies us with her rock fuel gas. The power for compression will be simply obtainable from a portion of the gas itself. Probably the most impressive way to make clear the advantages of this system of supplying a vehicle of power, heat, light and energy generally, will be to compare it in some detail with the other modes, in use or proposed, for conveying energy. These may be enumerated as follows:

1. Steam distribution.
2. Electrical distribution.
3. Compressed air distribution.
4. Natural gas distribution.
5. Illuminating gas distribution.
6. Producer gas distribution.
7. (And finally) Water gas distribution.

1. *Steam.*—The serving out to the public of this, as a medium of heat and power. is exemplified on a great scale, under the eyes of all, here in the American metropolis. It makes little progress, however, outside the "business" sections of the city, where the demand for operating passenger elevators and for heating huge office buildings is so great. It has as yet scarcely passed at all into any domestic use: and, for reasons, some of which are explained further on, must always be crowded out for such uses by gas, even if the latter cost more, which will not be the case with water gas. The cost of distribution, and of the plant, therefore, must always be far greater than with gas, under equal pressures, because not only must leakage, that is, escape of the material itself, be provided against, but also escape of the heat, which constitutes an additional loss, is constant and inevitable, and must be even greater than that from large leakages. *Distance* is here, therefore, a factor of leading importauce.

A direct comparison between steam and compressed water gas, in their relative capabilities as vehicles of heating power, may be interesting. For simplicity, we may assume steam of ten atmospheres or 147 lb. to the square inch, and that both agents are to be applied to heat water from the freezing to the boiling point, that is, through 180° F. Then 100 cu. ft. of saturated steam of 147 lb. pressure, which weighs 32·9 lb., will so heat

$$\frac{32\,9 \times 1{,}191}{180^\circ},$$

or closely 218 lb. of water; while 100 cu. ft. of water gas, of the above composition, compressed from 1,000 ft. to 147 lb. tension per square inch, will weigh 33·38 lb., and will evolve, on burning, 313.000°. Thus it can heat through 180° about 1,739 lb. of water, or almost *eight times as much* as with the steam. It will, moreover, remain in the reservoir or main containing it, if gas tight, indefinitely without loss of energy; whereas the energy of the steam cannot long be held or confined by any known means.

2. *Electricity.*—This system of distributing energy is now being worked out at monstrous expense in all countries, and has a great destiny before it. Insulation is the main consideration, and, unlike steam, distance is of minor importance. The trouble, so far, is the lack of a successful *reservoir* system for electricity. Storage batteries are expensive, bulky, heavy, and leaky, and, thus far, adaptable only to special limited kinds of work. The best system of the future is likely to arise out of the use for lighting and other electrical purposes of small isolated dynamos, operated by gas engines fed from water gas compressed in mains, or even in portable reservoirs. Such gas engines are, of course, readily adaptable to all other household uses, as pumping, ventilation, sewing, washing, and sweeping machines, elevators, and so on.

3. *Compressed Air.*—This has, over steam and electricity (though not over gas), the advantage that the distribution system constitutes an extension of the storage reservoir system, and, with good construction, without liability to waste. In this case, a distinct advantage is that, in case of leakage inside a building, though loss may fall on the producer, nothing detrimental or dangerous to the consumer can escape. The cold produced by expansion, in case of extensive usage, must often cause inconvenince. It is stated that in Paris this system has been employed satisfactorily on a considerable scale. But to this system the decisive objection applies that out of compressed air little or nothing is to be had more than the mechanical power that has been put into it. For domestic use it has no important value except for small power purposes. Compressed gas has clearly enormous advantages over it in the number and variety of household requirements it can be made to fulfill.

4. *Natural Gas.*—This being a local product, has little direct bearing on our topic. But the remark should here be made that were it possible to get marsh gas (methane), the characteristic product of the gas wells, cheaply, by artificial means, it would be far less suitable for domestic employment than water gas, by reason of its exceptionally great *explosive* energy, due to the great rapidity of propagation of flame throughout its mixtures with air. In this respect, the behavior of carbonic oxide, the characteristic component of water gas, is peculiar and so important that it ought to be clearly set forth. Flame is propagated through its mixtures with air with such comparative slowness that there is sometimes difficulty in obtaining what can be called an explosion when wanted. The passage of such a flame through a glass tube may be followed by the eye. Men accidentally immersed in such an exploding atmosphere in water gas works have escaped with little or no damage. Such an explosion, as the writer has himself seen, does not even scorch and char wood, whereas that of any gas based (like that from gas coal) largely on methane always blackens, and often inflames, wood, as in the case of firedamp in mines. Moreover, in mine explosions the flame often reaches the lungs or air passages of men with fatal after effects.

5. *Illuminating Gases.*—The distribution of these under small pressures all are familiar with; but not under the aspect that we have now to deal with. Under pressure it must fail. and probably has already failed, experimentally, in New York City. In the northern part of this city, above Central Park (and elsewhere), the principal streets were underlaid a number of years ago with a system of small screw-jointed steel piping, like that employed for natural gas. This was said to have been laid by the Standard Gas Light Company, presumably for the distribution of illuminating gas under pressure. The history of this experiment the writer does not know, but if for illuminating gas, it doubtless failed through the condensation of the illuminant hydrocarbons. This must always prove a decisive objection in such a case.

6. *Producer Gas.*—This mixture of gases is formed by action of air, or, more commonly, of mixed air and steam, on anthracite or soft coal, *in excess*, the object being to burn the carbon only to carbonic oxide, instead of carbonic acid, and is of extensive employment in metallurgical work. The following may be cited as the composition of an average air-steam producer gas, made from soft caking coals, and of the type made by the Siemens, Wilson and other producers in extensive use.

| | Volumes in 100 | Pounds in 100 |
|---|---|---|
| Hydrogen | 12·1 | 0·96 |
| Carbon monoxide | 23·5 | 26·16 |
| Methane | 6·3 | 11·04 |
| Carbon dioxide | 4·7 | 2·99 |
| Nitrogen | 51·4 | 57·42 |
| Moisture | 2·0 | 1·43 |
| | 100·0 | 100·00 |

Specific gravity at 60° F. = 0·87.
Total heating power per lb. = 2,438° F.
Total heating power per cubic foot = 162° F.
Weight of 1,000 feet at 60° F. = 66·44 lb.

The total volume of such gas from one ton of coal varies from 120,000 to 150,000 cubic feet, or 2½ to 3 times the volume of water gas obtainable. It will be seen, however, from the sum of the lower three constituents that nearly 60 per cent. of the volume and about 62 per cent. of the weight is useless and inert matter.

To economical distribution, either with or without pressure, this is a decisive obstacle. It is evident that to convey the same amount of energy, the distribution system would have to be correspondingly larger, at large additional cost; a remark applicable also to the storage plant and the compressing apparatus. This producer gas is sometimes hard to kindle without being first heated, and the cold produced by expansion from compression would prevent kindling altogether. Moreover, a dangerous feature, in all domestic use, would be that its flame is very *easily blown out.* Producer gas is adapted only for use at the point of production, while still retaining as much as possible of the heat of production.

7. *Water Gas.*—The mean of two analyses, by the writer, of the water gas of the Strong apparatus at Mount Vernon, in 1880, was as follows (purified):

| | Volumes in 100. | Pounds in 100. |
|---|---|---|
| Hydrogen | 50·15 | 7 04 |
| Carbon monoxide | 41·25 | 80·76 |
| Methane | 5·56 | 6·22 |
| Nitrogen | 3·04 | 5·98 |

Specific gravity at 60° F. = 0·437.
Total heating power per lb. = 9,322° F.
Total heating power per cubic foot = 313° F.
Weight of 1,000 cubic feet at 60° F. = 33·38 lb.

The estimate of Strong himself for the cost of putting such gas (unpurified) into the holders was 8 cents per 1.000 ft. As determined by the writer, 10 cents per 1,000 should cover everything, inclusive of purification. The cost of distribution under pressure could not be determined at present. An engineer's estimate would be required. One thousand feet of the gas was produced from less than 38 lb. of lump anthracite (with some culm), or over 50,000 ft. from a short ton.

B. Loomis, in a communication made in October, 1890, to the Institute of Mining Engineers, gave figures of *his* actual work in making water gas with coal at $3 per ton as ten cents per thousand, His make from 25 short tons of coal averaged but 40,000 ft. per ton; but he claimed to get in addition $40 worth of producer gas from the 25 tons. Loomis' regenerator chambers do not appear, from his cuts, to contain checker work, and may not recuperate fully. He valued his water gas at 340° F. per foot, but gave no analysis by which such figure could be verified.

Another analysis of simple water gas, made in 1878, at the works of the Municipal Gas Light Company, in New York City, by the writer, may be cited also.

| | |
|---|---|
| Hydrogen | 49·32 |
| Carbon monoxide | 37·97 |
| Methane | 7·65 |
| Carbon dioxide | 0·14 |
| Nitrogen | 4·79 |
| Oxygen | 0·13 |
| | 100·00 |

In such gas there is nothing left, after purification, of an *odorous* character; hence it will be necessary, to qualify it for distribution, to add some volatile hydrocarbon or other odorous compound, in minute quantity. Oil of turpentine or camphor may be suitable for this purpose, but objection may be made to these, through apprehension that the familiarity of their odors might prevent some from taking alarm in the case of leakage. Rudolph Wagner suggested some years ago the use for this purpose of *nitrobenzole*, a compound which has an extremely powerful odor, like the essential oil of bitter almonds. This might answer; but there are many essential oils of extremely characteristic and powerful odors, not in common use, which could be cheaply prepared for this purpose. Doubtless the more *repulsive* the odor, the better it would serve the purpose of an alarm.

The introduction of compressed fuel gas into use in cities would lead in time to great changes in human affairs. Vehicles would no doubt be built of all kinds, fitted with gas engines and reservoirs, the latter being charged at any time in a moment from a gas main. Charging stations could be established, if necessary, at all the important crossings of streets. Street cars would be moved in this way. The dream of sanitarians of banishment of horses and stables altogether from cities could be realized, and clean streets would then become a possibility. Invalids would then flee to cities, instead of fleeing from them. Smoke and ashes in cities would become traditions of the past. Quite possibly dust also. Even city noises might be largely abolished. Suburban residences throughout great areas around cities could have reservoirs supplied through pipes of very small caliber which, on a large scale, could be made and installed almost as cheaply as electric wires. The works manufacturing the gas need not be within the city, but may be at a considerable distance therefrom. One large works could supply several neighboring towns. The mechanical devices, which would be simple, for reducing the pressure, would, of course, be located *outside* the buildings supplied, as well as all local reservoirs. The meters, however, would, as now, be placed inside.

Ultimately, all lines of traffic, travel and transportation by land and water, including railways and common highways, will be provided with gas pipes, with reservoirs at suitable points, for charging vehicles, locomotives, vessels, etc., with the compressed gas; or for exchanging loaded reservoirs for exhausted ones, which could be accomplished almost in a moment. These things some may look upon as visionary, but the reader may be assured that they are substantial certainties of the future. They might be supplemented largely by additional suggestions, quite as sure to be realized in time.

## OIL IN COLORADO AND WYOMING.

THE producing petroleum district of the Rocky Mountain region is at present included in the district known as the Florence oil fields, in the valley of the Arkansas River, west of Pueblo. These oil deposits, while they have been producing for many years, are said by experts to be very different in their character from those of Pennsylvania and Ohio, for while petroleum in these States is invariably in large quantities in a stratum of sand below the shale, in Florence the oil is found in the shale strata itself; hence doubts are expressed by experienced oil experts as to the permanency of the supply. They do not hesitate, however, to assert that the oil exists in inexhaustible supply all through the Rocky Mountain sections of Colorado and Wyoming. The oil belt is known to extend from Central Wyoming south beneath the western portion of Colorado as far as the Grand Valley near Grand Junction. Even in the immediate vicinity of Denver, where experimental wells have been sunk to a depth of 2,800 feet, both oil and gas have been found, and those interested in these explorations express confidence in their ability to develop both oil and gas supplies within 10 miles of Denver. Their operations are confined to land located about 9 miles north of Denver. So, while the present productive oil field is limited to Florence, Col., and Casper, Wyo., the area of petroleum deposits is immense in its extent.

The output of the petroleum wells at Florence is about 2,000 barrels of crude oil daily, which produces from 36 to 40 per cent. of refined oil. The oil is pumped from depths varying from 1,400 to 2,100 feet and finds its way into storage tanks which have a combined capacity of 300,000 barrels. These wells have been pumping more or less daily for about eight years, and show no diminution in the force of the flow or change in the character of the oil. The Florence petroleum lands are owned by four large companies, as follows: The United Oil Company, capital $2 000.000; the Rocky Mountain Oil Company, capital $1,000.000; the Florence Oil Company, capital in excess of $500.000; and the Triumph, which is heavily capitalized. A total of about $4,000,000 for the Florence oil companies.

Fifty wells are now producing oil, and their combined product is estimated from 2,000 to 2,500 barrels daily. While only 50 wells are producing oil at this time, about 140 snafts have been sunk to the oil deposits, as follows: United, 73; Rocky Mountain, 35; Florence, 26; Triumph, 6.

Crude oil is refined in several large refineries, located at Florence and Overton, a village not far distant from the wells. The Overton refinery belongs to the Rocky Mountain Oil Company and pipes its crude oil through a 4 inch pipe from Florence, and has a capacity of 5,000 barrels a day. During the year 1893 the Florence Oil Company completed its second refinery at a cost of $75,000, with a capacity of 1,000 barrels a day. It will soon be in operation. The United Oil Company has made some costly additions to its refining machinery for the manufacture of fireproof oils for use in railroad cars, steamboats, etc. While no very extensive developments have been made in the way of output and increased number of wells during 1893, the

improvements made in the way of new refineries and improved machinery have been both costly and substantial the United Oil Company making an investment during the year in one instance amounting to $100,000.

Colorado's annual oil contribution to the wealth of the West amounts to at least $1,000,000 cash, derived from the sale of illuminating oil, machinery lubricants, tar for fuel, candles, axle grease and coke. About 300 men are furnished steady employment in the various departments connected with the oil industry, and the monthly pay roll is not less than $15,000. It is estimated that the outlay for labor for the year will not fall short of $180,000.

Separated from generalization and condensed into facts and figures, the progress of petroleum and gas development in Colorado and Wyoming during the past year may be summarized as follows: New oil wells, 12; new refineries, 2; increased output, daily, 500 barrels; number of men employed, 300; men employed in Wyoming. 50; monthly pay roll (Colorado), $15,000; annual output of oil in cash, $1,000,000; present daily output of oil, 2,000 barrels; natural gas discovered at Grand Junction, Col.

## VOSPER'S OIL ENGINE.

THE 16 brake horse power oil engine made by Messrs. Vosper & Co., of Portsmouth, for driving launches, illustrated below, from *Engineering*, has four cylinders, and receives two impulses every revolution. To make the engine easier to start, three of the cylinders are thrown out of compression, and the engine is started with a single cylinder. As soon as the one cylinder causes an impulse, the others are thrown into gear. Another advantage of the four cylinders is that by shutting the oil off from one, the speed of the engine can be reduced about forty revolutions. This is a great convenience in oil engines. The engine is fitted with two lamps, one to each pair of cylinders, each lamp heating its own vaporizer, D, and ignition tube, I The air is heated also by the same means by passing through a hollow cylinder, E, forming the casing for the lamp. The supply of oil is regulated by the size of the grooves in the reciprocating spindles, worked by the levers, M, but for various grades of oil the air can be regulated. The oil passes down the vaporizer, by the pipe, C, together with heated air, which passes through the pipe, F. The oil supply is pumped up from the main reservoir into two small tanks or receivers holding about one pint each, one to each engine. A very great improvement has been made by making these with glass sides, so that it can be seen at a glance that the oil supply is all right. J are the admission valves and G the exhaust valves, the latter being worked positively by means of cams deriving their motion from the crank shaft. The crank is incased, and works in oil. The reversing is done by a set of helical wheels, thrown in and out of gear by a friction clutch —a very neat arrangement, and answering well. The shaft, when going ahead, is coupled direct by means of the friction clutch, and it is only in going astern that the wheels have anything to do; and as they run in a bath of oil, the wear and tear and noise are very small. This engine was built for a steel yacht, 50 ft. over all by 9 ft. beam, lately launched for Mr. Harvey, of Nenagh, Ireland.

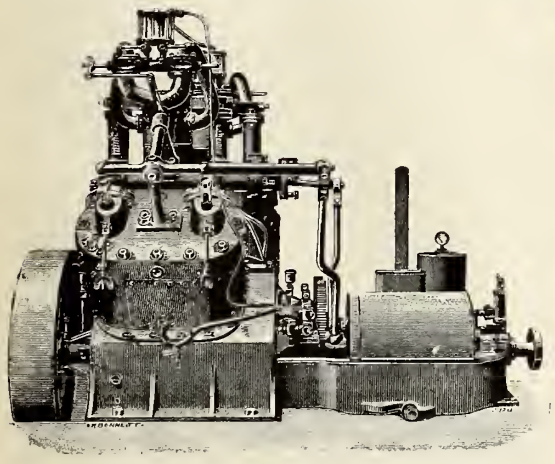


FIG. 1.

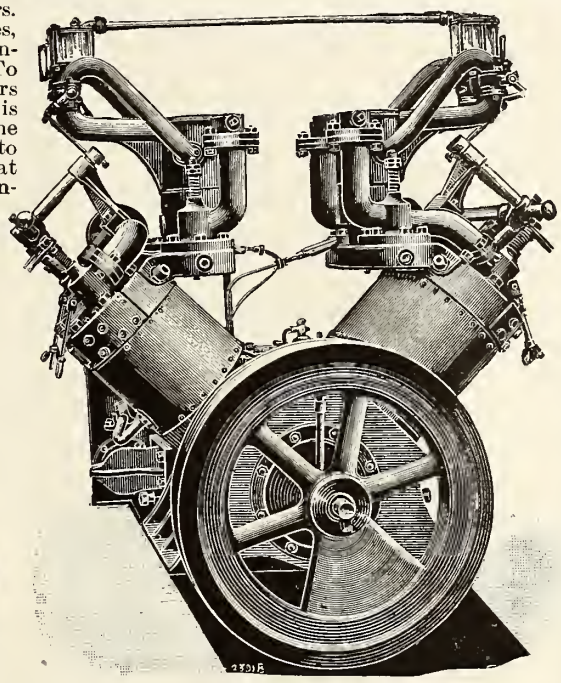


FIG. 2.

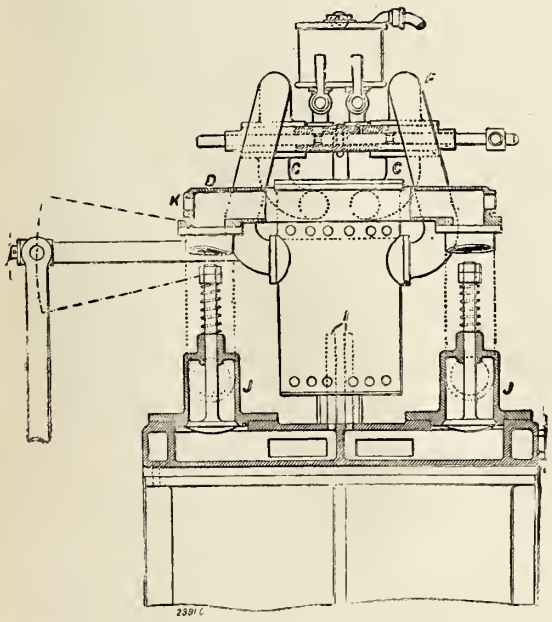


FIG. 3.

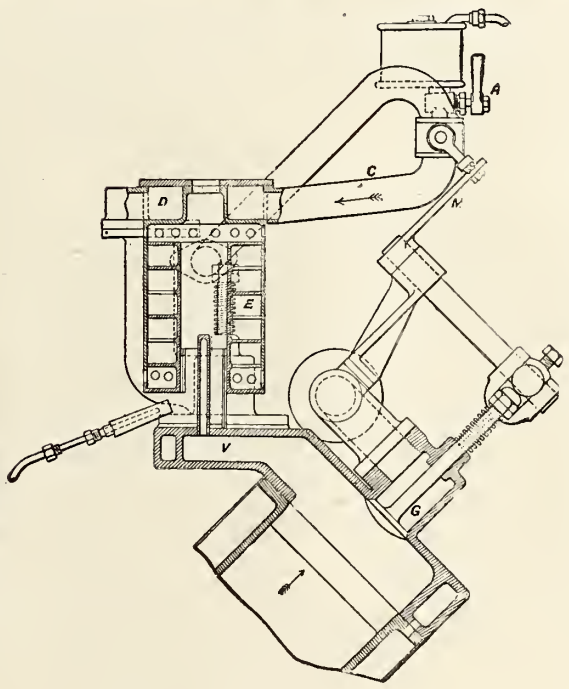


FIG. 4.

## SIXTEEN HORSE POWER OIL ENGINE.

drop with the force of their entire weight. The rods consisted of 1 in. or 1¼ in. square iron, and great difficulties were found in boring deep holes; first, by reason of the weight of the rods, and secondly, on account of the jar or vibration they sustained at each blow of the chisel The limit of depth to which borings on this system could be carried was usually taken at 1,000 ft.

It is true that the Chinese have sunk bore holes to a depth of several thousand feet, by means of a cutting tool resembling the modern chisel, weighing with sliding piece 200 lb. to 300 lb., and attached to a rope passing over a pulley, which is pulled up by hand several feet and then allowed to drop. The time, however, required to sink these deep holes was reckoned not by years but by generations. In course of time, as it became necessary to sink to greater depths, improvements had to be introduced in the construction of the tools and the arrangements of the mechanical gear used to supply the motion to the cutting tool in the well or bore hole. Thus, the walking beam was

* A paper read at a meeting of the Society of Engineers, Westminster, May 7, 1894, by R. Nelson Boyd.

## DEEP BORING NEAR FREIDSTADT, AUSTRIA.*

BEFORE entering on a detailed description of the particular boring to be described in this paper, it may not be out of place to say a few words on deep borings in general by way of introduction. The art of boring for minerals has been practiced by miners for centuries, but in past days the depths required and attained were shallow as compared with the present. The first bore holes were put down by hand labor, that is, by drawing up the rods and cutting tool, either directly with the aid of a rope passing over a pulley or indirectly by winding the rope round a winch. Subsequently steam power was applied to the winch, but the rope was still held by hand, and the action of the cutting tool in the bore hole was effected by raising it up a few feet and allowing the rods and the tools to applied, set in motion by a steam engine, and the "jars" and "free fall" tools were introduced to relieve the rods from the vibration consequent on the blow of the chisel on the bottom of the bore hole. Some such apparatus was necessary in order to prevent many accidents, which otherwise would occur in deep holes, through the breaking or bending of the rods or the falling in of the unprotected sides of the bore hole caused by the vibration of great lengths of iron rods. The introduction of these latter tools has been followed by a complete revolution in the art of boring, and has enabled depths of several thousand feet to be reached with a rapidity and economy not formerly possible. The deepest boring up to the present time, so far as the author is aware, is that of Schladebach, in Prussia, which is 5,736 ft. deep.

The so-called "jars" consist of two flat links of steel attached directly under the rods or rope, so that when the chisel strikes the bottom of the bore hole the upper link follows down until the stroke of the engine is completed, leaving the lower link and the tools alone to sustain the shock of the blow of the chisel. The links must be longer than the stroke of the engine beam, and in the Canadian rig they are generally 2 ft. 6 in. in length. The "jars" were first applied to boring in 1834 at a bore hole at Neusalz, in Germany, by the government engineer, Oeynhausen. This bore hole was sunk to a depth of 282 meters 51 c. (equal to 927 feet) with the usual tools, but by the application of the "jars" was subsequently carried down to a depth of 2,252 ft. The "jars" were soon replaced, on the continent of Europe, by the free-fall tool, where it was first applied by M. Kind, in 1844. The principle of this instrument consists of an arrangement by which the cutting tool is lifted with the upstroke of the walking beam, and then released by means of a suitable mechanism, allowed to drop, and give a blow in proportion to the weight of the tools and the length of the drop. In the Fabian and similar free-fall instruments, a rod to which the cutting tool is attached works in a tube or box. At the top of this rod is a pin, which by turning the rods slightly from the surface engages in a slot, and is thus raised by the upstroke of the beam. Then, generally by bringing the free end of the beam down on a block of wood, sufficient vibration is caused to disengage the rod in the box from the slot, and in combination with a turn of the rods by the driller the chisel falls freely to the bottom of the bore hole. This is the most simple contrivance, but sometimes the vibration is produced by bringing the end of the beam to which the tools are attached in contact with a properly fixed block of wood on the upstroke. The concussion, however, produced is considered by the advocates of this system of boring to be of great importance, as it limits the stroke, facilitates the turning of the beam, and liberates the free-fall tool. It must here be mentioned that a number of "free-fall" instruments have been invented to enable the cutting tools to be released without the aid of any concussion. It would hardly be within the scope of this paper to enumerate them in detail. Suffice it to refer to one or two of them. Thus Kind has a disk of sheet iron fixed on the top of the free-fall instrument, which is acted on by the column of water in the bore hole, and thus sets a click in motion which liberates the cutting tools. This arrangement implies the presence of a column of water in the bore hole. Again, Leon Dru depends, in one of his inventions, on the slight momentum acquired by the tools, below his apparatus, on the upstroke to loosen a catch moving on a joint, which holds the tools, and on the downstroke the rods act on this catch so as to free the tools, which then fall to the bottom of the well. The box containing the catch follows down, and the tools are again caught up and raised. In the continental boring apparatus the power is generally obtained by means of a single-acting steam cylinder applied directly at or near one end of the walking beam, the rods and tools being attached to the other end. The steam power is applied to raise the rods up and the downstroke is affected by gravity. In this system of boring iron rods are always used, and they are partly counterbalanced by weights attached to the end of the beam in order to reduce the work of the steam cylinder, and a second small engine is required for lowering and raising the rods, tools and sand pump in and out of the bore hole. The object of this paper is not to describe the various systems of boring in detail, but it has been considered advisable to allude to the free fall instrument as distinguished from the jars, one or the other being applied in nearly all the methods made use of in deep borings. There are several systems in which these tools are not required, as, for example, the diamond drill, the water pressure system, applicable to soft measures only, and Messrs. Mather and Platt's invention, by which the chisel is attached to a flat rope and falls with its full weight on the bottom of the bore hole, a fall which varies according to the size of the machine and the nature of the ground to be bored through from 2 ft. to 16 ft.

The experience of the author in boring deep wells for petroleum showed that the Canadian rig and tools, in which the jars are adopted, was preferable to any of the systems involving the use of the free-fall instrument, on account of the greater rapidity of boring attained by this system.

The Canadian method originated in the early development of the petroleum fields of Petrolia, Ontario, which followed shortly after the first oil well was put down near Titusville, Pennsylvania, in 1859. At that time the so-called wells or bore holes were sunk by hand, and in this operation iron rods have always been, and are to this day, generally used. It is probable that the early Canadian drillers adopted ash poles in lieu of iron, in order to reduce the weight, and subsequently, when steam engines were introduced as motive power, they selected the American drilling tools, and in so far the Canadian method of drilling may be described as a modification of the American, the only difference being that in the former ash poles are used and in the latter a rope to convey the necessary motion to the cutting tool or chisel at the bottom of the bore hole or well. In the American method the so-called "jars" or "slips," consisting of two flat links of steel, in place of the box and catch used in the free-fall system, have always been used.

One advantage of the jars, among others, lies in the continuous and rapid working of the apparatus. In good drilling ground it is not exceptional to run at the rate of 60 and even 70 strokes a minute, either with

wooden rods or ropes. The jars were adopted in America on the application of steam power in conjunction with the heavy tools necessary for drilling with a rope. In the United States the rope is generally made of hemp 1¼ in. diameter, and is kept taut by means of heavy weights, termed sinker bars, and these, together with the string of tools, make up a total weight of about one ton. This arrangement has been most successful in sinking deep wells in the oil regions of the United States. It is especially adapted to the stratification of the ground in Pennsylvania, where the beds lie at a gentle inclination and consist mostly of sandstone and slaty shales, which are easily bored through and yet sufficiently firm to stand without the necessity of casing or lining. The oil and gas wells of the United States attain a depth of over 3,000 ft., and are economically sunk by means of the rope system. In boring to a great depth in Pennsylvania, it has been found advisable to use a flat hemp rope instead of a round one. Steel ropes have been recently introduced, but have not been as yet adopted generally. In Canada, where the wooden poles are customary, the depth of the wells does not exceed about 500 ft., and as the ground is exceptionally easy for drilling, as much as 100 ft. can be sunk in a day.

In the Petrolia oilfield a good set of drillers reckon to finish a well, that is to a depth of 500 ft., within a week. Similar results have been realized in Galicia, and in good drilling ground over 100 ft. a day have occasionally been sunk. But rapidity of drilling by this method can only be realized in wells of moderate depth, because the time occupied in screwing and unscrewing the rods is considerable, and in deeper wells the advantage as to speed belongs to the rope system. In order to exemplify this, the author is able to give the following record of the time occupied in drawing and letting down the rods at a deep well in Galicia, Austria, as noted by himself. The well at the time was 470 m. deep, *i. e.*, 1,542 ft., and sunk by competent drillers:

| | Minutes. |
|---|---|
| Drawing up the rods | 25 |
| Letting down the sand pump by means of rods | 14 |
| Drawing it up | 24 |
| Changing the chisel | 3 |
| Letting down the chisel | 14 |
| Connecting the beam | 5 |
| Total | 85 |

The author observed the same operation performed, with the rope, for a depth of 1,600 ft., in the Bradford oil district in Pennsylvania, when the time occupied was found to be about twenty minutes. A small wire rope worked by separate gear is sometimes used for lowering, working and raising the sand pumps, in which case the eighty-five minutes mentioned above would be reduced to fifty-five minutes. But this arrangement cannot always be applied. For instance, in Galicia, Austria, where the Canadian system of drilling has been successfully introduced, it is the custom to line the bore holes or wells with riveted sheet iron casing, instead of lap-welded tubes, for reasons of economy, and these are put in telescope fashion, leaving the inner length of casing slightly projecting. It is evident that it would be absolutely impossible to keep the sand pump perfectly steady in its rapid descent, and consequently the danger would arise of striking the projecting rims of the casing, and thus damaging, and perhaps destroying, the well. The experience of the author justifies him in condemning this mode of lining oil wells. The first cost is certainly much less, but the economy is more apparent than real. In bad ground the sheet iron riveted pipes are apt to bulge in, and owing to the loose riveting and the open space at the junction of each string of casing, the lining of the bore hole cannot be perfect. Moreover, if the well yields oil for several years, the thin wrought iron is certain to corrode, and fresh casing will have to be put in. Lastly, the sheet iron casing will not bear moving, and cannot be drawn out of the well when it comes to be abandoned. In a trial boring intended only to explore the strata, the short life of the casing is not an important factor, and in this respect sheet iron may be used.

The so-called Canadian drilling rig as used in Austria, and in the boring to be described, consists of a derrick or staging 56 ft. high, 16½ ft. square at the base, and 3¼ ft. square at the top. This is usually constructed of timber; but of late years derricks of wrought iron have been introduced, which have the advantage of being easily taken to pieces, removed and put up again. In the front of the derrick is a narrow door, about 15 ft. high, to enable the tools and casing to be taken into the structure. The engine is fixed in a shed adjoining the derrick. The boiler in another shed, placed at some distance, when the boring is for oil or in strata likely to emit explosive gases. The derrick is close-boarded. It is supported on "runners" or sleepers which are fixed on balks of timber termed "mudsills." The engine is of a simple horizontal construction, having one cylinder 10½ in. diameter and a flywheel. On the flywheel shaft there is a pulley which drives, by means of a strap, the "band wheel," which is about five times the diameter of the pulley. This "band wheel" works one end of a walking beam up and down by means of a connecting rod attached to it by a pin, revolving in a circle about one and a half times the diameter of the pulley. On the other end of the walking beam is fixed a spring pole sustaining the drilling tools, by means of a short piece of chain, gripped in spiral cast iron grooves firmly fixed on the end of the spring pole; this chain is wound round a reel fixed on the walking beam about the position of its fulcrum.

The apparatus is designed, by the oscillations of the walking beam, to give an up-and-down movement to the rods and string of tools in the bore hole. In the rig used the fall allowed was 18¼ in. The reel above named enables the chain to be paid out as the boring descends, by means of a "slipper out," which is a combination of pawl and ratchet acted on by a string at the command of the driller. Besides the drilling apparatus proper, there is another appliance attached to the engine for removing or replacing the various tools in the boring. When it is to be worked, the walking beam connecting rod must be disconnected, then the driller, by the aid of a brake, can control the appliance, which consists of a winch capable of winding up on its barrel a length of rope equal to the length of one of the rods. The rope is carried over a pulley at the top of the derrick and terminates with a heavy cast iron weight called a "cow sucker," to bring the rope down to the level of the bore hole. On the lower end of this there is an attachment screw fixed on a swivel, which fits others on the rods and tools. The swivel enables the driller to turn the tools round, an operation which is necessary in all kinds of drilling where a simple bit or chisel is used, in order to keep the hole round and the bottom level.

It is not necessary here to catalogue all the tools used in the Canadian system of drilling, as most of them are common to all methods of boring; suffice it to state that a "string of tools" consists of the jars, sinker bar, guide and chisel. It is frequently necessary to undercut in the process of boring, for which purpose an instrument called a "riner" is resorted to. The riner used in the boring at Freistadt was fixed about 2 ft. above a chisel of smaller diameter, and consisted of two projections or wings of steel slung on pivots, which were pressed outward by means of a spiral spring, so that while being lowered down in the casing the wings rubbed against the sides, but immediately they reached the body of the casing they sprang out and cut away the ledge left by the chisel. All the tools are fitted with conical screw joints, and it is important that these joints should have exactly the same thread so as to be interchangeable. As the poles are drawn up they are received and detached by a workman at the top platform of the derrick, while the driller at the ground level rests them on the wrench block, a piece of timber covered with sheet iron, and having a rail at one end to prevent the poles from sliding off. The combination of parts in the Canadian apparatus is designed to give the driller complete control, within limits, over the velocity with which the chisel strikes the bottom; the highest velocity of the chisel being that of the end of the walking beam when its movement brings it to a horizontal position. The driller regulates the velocity of the tools in accordance with the nature of the ground to be bored through. It is needless to state that he has the engine under his control by means of a string communicating with the throttle valve. The velocity of the chisel in the free-fall system is that due to the height from which it is allowed to fall, which does not exceed about 4 ft.

The rig thus succinctly described was the one used in the boring undertaken for the purpose of an exploration for coal in Austria, the details of which form the subject of this paper. However, before deciding on the adoption of the Canadian method for this purpose, the advisability of using the diamond drill was considered, and a shaft was sunk to a depth of 30 ft. to ascertain the exact nature of the strata near the surface. The only advantage of using the diamond drill would have been to secure a core of the carboniferous rocks, and identify them with the known beds found in the pits of neighboring collieries. Otherwise the diamond drill is not reliable for proving coal properties. A core can only be secured in passing through hard ground, and in the carboniferous measures, the clays, soft shales and coal seams, unless of a very hard nature, may be passed through without obtaining a core or record. In this case, however, the overlying tertiary beds were of such a nature and thickness that the diamond drill would have been quite inapplicable. The bore hole was put down in an unexplored part of the Austrian Silesian coal field, known as the Ostrau-Karwin coal basin, which is situated close to the north-west frontier, and forms an extension of the Prussian Silesian coal field. It is the only important deposit of palæozoic coal in the Austrian dominions; lignite and other coal exist in great quantities in Bohemia, Carinthia, Hungary, and other provinces, but palæozoic coal only in the Ostrau-Karwin coal field and over a very small area in Bohemia. The importance of this coal field to Austria can scarcely be overrated, as it is the only source of supply of coke and iron furnace coal in the country. The basin, so far as known at present, extends from Schonbrunn in the west to Karwin in the east, a distance of about 24 kilometers (15 miles) and the average width is about one mile, so that the basin as known covers an area of 15 square miles. The seams proved up to the present time number 26, with an aggregate thickness of 43 m., more or less. These seams are not all workable, but 13 are over one meter thick and one of the lower beds attains a thickness of 8 m. 16 c., with a small clay parting of 46 c. The end of the coal formation to the north and west is well defined by an outcrop of culm beds. Toward the south the boundary is also defined by limestone of the secondary period. But in the easterly direction at Karwin, where the seams are being worked without any signs or indications of a break beyond ordinary faults, the end of the coal basin is not defined. The greatest part of the basin is covered by beds of clay belonging to the tertiary formation, varying in thickness from a few yards to 250 yards. This deposit of tertiary clay is considered by Austrian geologists to be similar to the beds of the Vienna basin, and is locally known by the name of "Tegel." It is divided into two beds, of which the lower one is so tough that it has to be blown down with gunpowder in sinking shafts, but in presence of water and air it soon disintegrates and swells, so much so that sinking through it is a difficult and expensive operation. It contains small quantities of chloride and iodide of sodium. The two beds of this tertiary deposit are considered by Herr Stur to be identical with strata on the shores of the Mediterranean, and he classifies them as Neogene—a name given by some Continental geologist to the groups of Pliocene and Miocene strata. To the eastward of the existing pits this clay deposit continues, and until lately there was no positive evidence as to its thickness in this direction. However, some years ago a bore hole was sunk about a mile east of the extreme easterly coal workings to a depth of 269 yards into the clay without passing through it. This bore hole gave out a great quantity of coal gas, so much so that an explosion occurred in the drilling shed, which destroyed the machinery and stopped the bore hole; and it was assumed from that circumstance that the coal seams were not very distant. The great probability of the coal seams extending toward the east of the basin was also supported by the fact that the Prussian Silesian coal field lies in that direction, and the Ostrau-Karwin basin has always been accepted as forming part of this extensive field. These and other facts drew attention to the advisability of putting down a bore hole to test the extension of the coal. A concession of some 2,000 acres was secured by lease and this boring was undertaken for the purpose. In the western part of the basin the tertiary deposit has an average thickness of 50 to 100 yards. In some points the coal measures crop out to daylight, and at others they are covered by the tertiary deposit to a thickness of 250 yards. At Karwin, the extreme eastern point of the basin under exploitation, the thickness of tertiary clay is 90 m. Beyond this point toward the east nothing was done to discover the continuation of the coal measures except the bore hole already referred to, until it was decided to put down, under the direction of the author, the bore hole now to be described.

About two miles to the north of the workings of the Karwin coal pits the river Olsa flows from east to west, and it was supposed possible that, through erosion, a considerable part of the upper coal measures would be washed away in the valley of the river and replaced by tertiary deposits. The bore hole already alluded to was the only exploring work carried out, and this proved 246 m. of clay and the presence of inflammable gas. The bore hole under consideration was placed on rising ground about 2½ miles from the extreme easterly workings of the Karwin collieries and 1¼ miles from the old bore hole, and was assumed to be favorably placed at the edge of the valley of erosion and in the direction of the general strike of the coal seams. In view of the nature of the ground at Freidstadt it was considered advisable to commence the boring with a diameter of 18½ in., which was carried down to a depth of 26 m. 60 c., when the caving necessitated lining the bore hole, which was done with sheet iron casing made of plates 3 mm. to 4 mm. thickness (about ⅛ in.) The boring was then continued within this lining with a chisel 17½ broad, down to 96 m. 47 c., and again lined with sheet iron casing. This string of casing was armed with a steel shoe and driven down from the surface by the walking beam. Within this the next length was put down with a 16 in. chisel a depth of 141 m., and lined with casing 14 in. in the clear. This was also driven from the top, so that the upper three strings of casing were put down from the surface. The next length was bored with a chisel 13⅓ in. down to 40 m. 95 c., and lined with a 12 in. casing. This casing was not put down from the surface, but telescoped in the outer casing. It was also armed with a steel shoe, and it was attempted to force it down, as the upper casing had been from the surface, but this was not very successful, and the attempt to force the casing below this was abandoned. The boring was continued with a chisel 11¾ in. down to 32 m. 80 c., and lined with 11 in. casing, which telescoped with the upper casing for about 1 m. The next chisel was 10½ in. and the casing 9 in., length 28 m. 17 c.

| | | | | |
|---|---|---|---|---|
| Then followed | 38 m. | lined with | 8½ | in casing. |
| " " | 28 m. 13 c. | " | 7½ | " |
| " " | 29 m. 15 c. | " | 7 | " |

The bore hole had now reached a total depth of 388 yards, and as no signs of change of ground were perceptible, it became clear that it would have to be put down to a considerable depth. The last five strings of casing had averaged 102 ft. and had lost 5 in. in diameter over a depth of 170 yards, or at the rate of 1 in per string. The diameter of the bore hole was now 7 in., and taking 4 in. as the smallest working diameter, there remained 3 in. for casing, or 3 strings of 31 m., say 93 m. This was not considered enough depth, and the author then determined to continue the boring with lap-welded artesian casing with screw joints. Accordingly a string of 6 in. casing was put down, extending from the top, and the boring continued with a riner or under-cutter giving a diameter of hole 6 in. This case was securely fastened at the top, and when sufficient ground had been undercut one and sometimes two pipes of 5 m. length were screwed on at the top and the whole length let down by means of a set of strong pulley blocks.

The boring was successfully carried on by this process to a depth of 435 m. 95 c., when an accident occurred which interrupted further progress. On the 2d of October, 1890, in moving the artesian casing in order to add a length at the top, the screw of the third pipe from the surface slipped and the whole string of casing dropped to the bottom. Every effort was made to raise it without success, and the author then determined to continue the boring from the depth of 436 m. 95 c., now cased with 6 in. casing, by running a string of 5 in. artesian casing inside the 6 in. casing. This was accordingly done, and the hole was successfully carried down to a depth of 613 m. 15 c. The 5 in. casing had been lowered to a depth of 581 m. 49 c., that is, 144 m. 14 c. below the 6 in. casing; at this point, in trying to lower the 5 in. casing, it was found that it was held fast by the swelling clay. Under the circumstances it would have been necessary in order to continue the boring to put in a third string of artesian casing 4 in diameter, and as this would have been the last string under any circumstances, sheet iron might have been used. The former would have secured a further depth of 150 m., the latter probably 80 m. to 100. In either case a new set of smaller tools would have been necessary, and under the circumstances, considering the great depth already reached without any decided change in the ground, it was determined to stop further drilling, as the discovery of the coal at such great depth would not have been of compensating value. As soon as it was determined to stop the drilling, arrangements were made to draw the casing out of the bore hole. On the 11th of April, 1891, this work was commenced. The casing had now been standing in the bore hole for five weeks, and it was to be expected, would be tightly jammed by the clay. Therefore, every precaution had to be taken. It was soon found that the fall blocks were insufficient to move the casing, and a pair of jacks had to be applied. By this means the first pipe of the 5 in. artesian casing was raised inch by inch out of the bore hole. The next 87 pipes were raised by the pulley blocks, and the remainder hanging quite free in the 6 in. casing, were raised by the rope and drum of the rig. The 6 in. casing, which had run down, was caught again by letting down a length of three pipes and screwing them on from the surface. But on attempting to raise them the screw slipped again, and only the three upper pipes were raised. An attempt was then made to raise the casing by letting down an expanding tool made of steel, and intended to secure the casing by cutting

into it. But the casing was so jammed by the swelling clay that the instrument on being drawn up ripped through the wrought iron casing and came up damaged itself, but without moving the casing.

The boring was commenced on September 29, 1889, and stopped on March 20, 1891, at a depth of 613 m. 15 c., equal to 2,011 ft., having occupied one year five months and five days. During this period several delays occurred, such as waiting for tools and casing, a few accidents intervened, and in the early part of 1890 the fire box of the boiler gave way, and had to be repaired, which caused a delay of six weeks. Taking the time occupied in completing the boring, namely 520 days, the averaging sinking amounts to 3 ft. 10 ½ in. per day. Eliminating the stoppages, and taking the time of effective working, namely 265 days and 12 hours, the drilling amounts to 7 ft. 9 in. per day. These 265½ working days were employed as follows:

| | | | |
|---|---|---|---|
| Drilling | 190 days | 8¾ hours. | |
| Using the sand pump | 42 " | 2¾ " | |
| Putting in casing | 9 " | 1 " | |
| Fishing up broken tools | 8 " | 3¼ " | |
| Small repairs to engine and rig | 15 " | 20¼ " | |
| | 265 days | 12 hours. | |

The actual drilling averages 10 ft. 6 in. for twenty-four hours. The greatest distances drilled in one day were: 22 ft. 4 in. at a depth at 174 ft., 20 ft. 4 in. at 300 ft., and 22 ft. at 1,883 ft., and 21 ft. at a depth of 1,922 ft. The bore hole was perfectly straight, and ended at the total depth of 2,011 ft., with an internal diameter of 4½ in. The point of interest attached to this boring is the great thickness of clay which has been passed through. The mere depth is not very considerable as compared with many other bore holes put down in recent years, but the author is not aware of any bore hole which has been put down through over 2,000 ft. of swelling and adhesive clay. At times the chisel stuck so fast in the bottom that it took all the power of the engine to drag it out, and frequently the rods broke. On two occasions the chain gave way, and some conception of the strain may be formed from the fact that it was made of 1 in. iron. When the chisel stuck, and the full power of the engine was applied, the whole rig oscillated about like a ship at sea, yet no serious accident occurred during the process of boring, and it is a great point in favor of the Canadian system that this, which may be considered a difficult boring, was successfully carried out by that method. It may be interesting to state that inflammable gas was first observed at a depth of 702 ft., and from that depth onward became more abundant as the boring proceeded. When drilling was not going on, the noise of the bubbling gas in the bore hole was like the boiling of a gigantic caldron. A strong fresh water spring was struck at 960 ft., and a little down at 1,010 ft., a spring strongly charged with salts, mostly chloride of sodium, but also some bromide and iodide. The quantity of these valuable salts contained in the brine from the "Tegel," is about 1·50 grammes per 10,000 grammes of water. A similar spring of iodide and bromide salts was found in the boring previously referred to, and after the explosion, which stopped the sinking, this spring was profitably applied. In the winter the brine is pumped up and evaporated to dryness, and in summer it is used for baths and drinking in a bathing establishment erected for the purpose in the vicinity. The cost of this bore hole can only be approximately given. It amounted to over £2 per foot. The work was not carried out by contract, and the cost includes the purchase of the tools, casing, and machinery, less the amount realized by their sale at the end of the work.

In conclusion, the author would observe that, taking one consideration with another, the Canadian system of drilling has many advantages. In ground where the strata are much inclined it is preferable to the rope system, because it is difficult to keep the hole perpendicular by the latter method. By the use of the jars a much greater rapidity of drilling is secured than with the free-fall tool. Lastly, in soft ground it is possible to bore and obtain a section, which could not be done with the diamond crown. The latter is admirably adapted for drilling through hard ground when a core can be secured, but in softer measures it is not reliable as indicating the nature of the strata, and it is well known that even a seam of coal may be passed through with the diamond drill and not be recorded in any way. The Canadian method of boring has hitherto been almost exclusively applied to petroleum wells in easy ground, but it can be used for deep bore holes through difficult ground, as may be seen from this boring successfully carried down upward of 2,000 ft. through nothing but clay.

The president said he was sure they would all be desirous of giving a hearty vote of thanks to Mr. Boyd for his valuable and interesting paper, and as he was not aware that they had ever before had a paper on that subject, it would be a useful addition to their *Transactions*. There were several questions he would like to ask: first, as to the height of the fall, as 2 ft. 6 in. seemed such a small fall, and he would also like to know the weight of the tools that did the duty of the blow at the fall; second, as to whether there was any mechanical apparatus for turning the tools round, or whether it was done by simple muscular exertion; third, with reference to the sheet iron tubes, ⅛ in. thick, whether the rivets would not foul the tools as they dropped down, on account of the thinness of the material; fourth, was any record kept of the temperature? He presumed the cause of the rods frequently breaking was the constant concussion.

Mr. Boyd, replying to the questions which had been raised, said that the total weight of the tools which he had had to deal with, which were the Canadian principally, ranged from 10 cwt. as a minimum to a ton as a maximum. It was an easy matter to turn the tools round, because when they came to the top there was just a moment at the turn of the engine when, irrespective of the weight, the whole set of rods and tools could be turned by means of a swivel, and when the machine was going at sixty or seventy strokes a minute a very small turn was sufficient to answer the purpose. As to the question of rivets and the linings, he referred to the statement in the paper that his experience justified him in condemning that mode of lining the wells, except it were of a very temporary character, such as exploring for coal, but in the case of water or oil wells of a permanent character experience had proved that it was preferable to use a substantial rather than the cheap sheet tubing which he had described. The difference in price between the two tubings would be as between 4s. and 12s. When they used the American connecting wooden rods they broke very frequently, not with the concussion, but with the draw-up, because of the adhesive character of the clay and the difficulty of getting the chisel out of it. As a general rule, when they were not putting down such a preposterous hole, as he called that with which the paper dealt, not through clay but through fair ground, the rods were broken when the chisel struck the bottom. He had taken the temperature on several occasions but did not consider the results worthy of record, because they came across a very large spring of fresh water at a shallow depth, which absolutely interfered with reliable results. He was glad to hear Mr. Stockley's defense of the American system. He, however, considered that they would be able to feel the blow at the bottom just as well through the ash poles of the Canadian as the hemp rope of the American, for there could not be much difference in the rigidity of the ash pole and of the hemp rope. He admitted, however, that the American system had two advantages, viz., that they could bore a hole of much smaller diameter and they could bore much more rapidly than was the case with the Canadian system. He added that his experience in drilling in Pennsylvania was that he always found difficulty in keeping a straight hole with the American system, in spite of all the measures that were adopted. His experience in deep coals in Hungary and Galicia, where the strata were of an entirely different order, owing to the existence of the Carpathian range, was quite different, for they had to drill at angles at from 1 in 45 to 1 in 80; there the American rope system had been tried and found wanting, but the Canadians had come over, and by rearranging the tools they had been able to bore down there to depths of 1,500 or 1,600 ft. In order to keep the hole straight the only way was to use guides, whether working with the Canadian or the American system. The length of the pole used in the boring was 42 ft. As to the cost of sinking wells by the Canadian system, he had sunk them for 16s. a foot, while other wells cost as much as 30s., but the average cost might be taken at £1, the difference entirely depending upon the character of the ground they had to pass through. He had been somewhat taken to task on the question as to the depth at which they might find coal of compensating value. That was a point on which he could speak with some accuracy. In that case they sank down over 2,000 ft.; there was no change of ground whatever from a depth of 1,000 ft., and they could see not the slightest trace of the coal measures. Supposing, within the next 100 yards, they had struck the sandstone above the coal measures, it was a question of how much deeper they would have to sink to strike the coal itself. It would be at least 1,000 yards before they got to the first seam, and it was thought, considering the great outlay in sinking to that seam, it was not worth getting at that depth. Replying to other questions, Mr. Boyd said that the largest tubes were about a yard in diameter, but there was practically no limit to the size; the stuff inside the tube was carried out by means of a sand pump; that ordinary cartridges were quite sufficient to remove anything that the chisel would not move; and that while 20 lb. was sufficient pressure of steam when drilling, they required a pressure of 60 lb. to bring the tools up. The deepest hole that they had been able to discover was 5,000 ft., but he did not see why they should not make their arrangements for 10,000, 20,000 or 30,000 ft.

## GAS MOTORS FOR STREET RAILWAYS.

MR. WM. E. MCKAY, U. S. Consul General for Germany, reports to the State Department as follows:

There is in the mechanical record of the past year in Germany no fact more noteworthy than the trend of expert opinion in favor of gas engines as motors for street and suburban railway cars. This has come at a period when electricity seemed to be on the point of replacing and superseding all other forms of motive power for this special purpose, and when the construction, equipment, and economical working of street railways have been more than ever before in this country the subject of practical experiment and scientific study.

In a general way Germany has hitherto been far behind the United States and some other countries in the adoption and extension of street railways. The rapid increase of population in the cities and industrial towns has recently attracted special attention to this subject, and, before investing their money and giving up their streets to tramways, the various municipalities have, with characteristic foresight, taken up the study of the several competing systems in a very thorough and deliberate manner.

The objections to horse railroads are well known. Although cheap and easy of construction, and although horse cars are the simplest and lightest vehicles that have ever been devised for such a purpose, such roads are unclean, and, in the end, expensive to operate. Horses and forage are both costly in Germany; the animals are exposed to accident and disease, and in case of war would be subject to immediate conscription for military purposes.

Steam tramways are noisy, terrifying to horses and timid people, dirty by reason of smoke and soot from the engines, and, what is still more serious, they can only be operated profitably on lines where the travel is regular, constant, and sufficiently heavy to require one or more cars to be attached to the motor vehicle. Recent improvements have modified to some extent the first two of these difficulties. There are in operation, for instance, on the suburban line between Wiesbaden and Bieberich, locomotive cars which run quietly and emit little or no soot or smoke; but they cost nearly $6,000 each, require both an engineer and fireman, and are for other reasons impracticable for street service in crowded cities.

Cable roads are costly to build. Their construction involves the tearing up of streets and underground constructions, which the German municipalities are loath to permit, and in operation the cable must be kept going throughout its entire length, with all incidental loss of power through friction, the same during all hours of day or night, no matter what may be the varying requirements of travel. Then, unless a double line is provided, the breakage or jamming of the cable or any accident to the engine paralyzes instantly the entire system. So that, while cable roads are admitted to be most advantageous for steep ascents, they are considered in this country as open to grave objections for ordinary use in crowded streets.

Electricity, as now applied, solves many of the difficulties which have hitherto beset other methods of propulsion, but every one knows that the noise, the danger, and unsightliness of overhead wires, and the high cost, as well as the waste and uncertainty of underground lines, are serious objections, and entail general complaint. Here, too, the current must be worked at full energy whether there are 10 cars or 20 or 50 in service at any specified moment. Of course, all scientists hope and expect that a perfect storage battery system will yet be developed, which will abolish both ground and overhead currents, and make each car independent; but at Brussels and Hamburg, where storage battery cars have been extensively utilized, the accumulators must be changed once in from 3 to 5 hours, and weigh from 2 to 4 tons for each car, giving a dead weight and cost of manipulation which, added to the large percentage of loss in electrical energy, leave this method at its present stage open to serious objections from a practical standpoint. Twenty, or even ten years hence, the storage battery motor may be the ideal one, but it is not so yet.

The problem from the German standpoint has been to devise a motor which shall render each passenger car independent—one which, during days or hours of increased travel, can draw one or more additional cars, which can be run upon rails laid at any reasonable grade without overhead wires or any subterranean construction; a car which can be started and stopped quickly and surely by one man, which can be supplied in any required number during the busy hours of the day, and when not in use can be run into a shed and left, without consuming or wasting anything, ready for immediate service when needed, a car that shall run silently without hissing steam or defiling smoke, and which shall be withal not too costly in construction or too complicated to be handled and kept in order by an average mechanic.

These requirements, in the opinion of many experts, narrow the choice down to two forms of motive power—coal gas and compressed air. The use of compressed air for such purposes is perhaps still in its infancy, but its advantages are frankly conceded. It is clean and quiet, it causes no smell or unpleasant heat, and the car is under perfect control, and is wholly independent of wires or other connections along the line. But in Berne, where air compressed by water power under highly advantageous conditions has been used, it is found that at a pressure of 32 atmospheres 4·2 cubic meters of air are required to produce one horse power, or about 150 cubic feet per horse power per hour. Each car carries 12 reservoirs, with an aggregate capacity of 2,170 cubic feet, which can be filled from the main reservoir in 8 minutes. Thus provided, the car, which at Berne weighs when empty about 7 tons, can run 12 miles, but at an expense of 15 cents per car mile, which exceeds the cost of horse power. On certain lines which lead through luxurious suburbs, where travel is heavy and high fares may be charged, compressed air may be recognized as the ideal motive power of the future. But since it is found that in Berne, with all its advantages of compression by water power, the cost of operation exceeds that of horse cars, the chances would seem to be against its general adoption for ordinary city and suburban lines.

A careful study of the whole subject has led to the adoption in two notable instances of cars propelled by gas engines. These practical trials have been made at Neufchatel, in Switzerland, and at Dresden, and the results in both cases, although not yet perhaps wholly conclusive, have been so favorable that they seem to be worthy of examination. The conditions to be met in Neufchatel and at Dresden were somewhat different, but they are substantially similar to those which exist in many of the smaller cities of the United States.

At Neufchatel there was required a new line 3⅓ miles in length to connect that city with the village of St. Blaise. Nine-tenths of the distance lies outside of the city limits, and through a district which could furnish but few passengers. The estimates had to be made on a basis of one car either way every half hour during 14 hours daily service, with an average of seven passengers per car, each paying 5·7 cents for the through outward or return trip. The contract for the equipment was let to a firm in Vevay, which undertook and fulfilled the task of providing motor cars to be driven by gas engines supplied with ordinary illuminating gas from the city mains. These cars are strong and practical in construction; they run quietly, without jar or smoke, stop and start quickly, and the machinery requires to be cleaned but once a week. Each motor car carries 20 inside passengers, and weighs, when filled, about 6 tons. They cost, delivered at Neufchatel, $2,856 each. These cars can pass curves of 100 ft. radius, run backward or forward with equal facility, and with 7·9 horse power are able to traverse any part of the line—which is 40 ft. higher at the midway point than at either terminus—at a speed of 11 miles per hour. Gas compressed to 6 atmospheres is furnished by the city gas company at $1.09 per 1,000 cubic ft., and it is found that under such conditions the cost of gas per car for the round trip, 6⅔ miles, is 19·3 cents, or about 1 cent per passenger for a filled car, or half a cent per passenger for the single run from Neufchatel to St. Blaise or return. This brings the net operating expense per passenger so far below the cost of electricity, horse power, steam, or compressed air that, although the experiment is still new, the problem is thought to be solved in favor of gas for all roads of a similar class.

But by far the most elaborate and interesting experiment is that which has been made at Dresden, where a street railway about three miles in length is operated with gas motor cars invented by a German engineer named Luhrig, and built by a company at that place, the engines themselves being supplied by the well known Gas Motor Fabrik at Deutz. This system has been in operation for several months, and has been the subject of careful study and investigation by committees and experts from other municipalities which have

in contemplation enterprises of a similar nature. Among others, the city of Nordhausen sent a commission headed by a government railway engineer to examine and report on the working of the new system, and the report of this committee, while recognizing that there remain some minor difficulties yet to be overcome, declares the system a practical success and recommends its adoption at Nordhausen. At Dessau another line to be similarly built and equipped is now under construction, and will be put in operation during the present summer. Germany has therefore definitely started toward the adoption of gas motor cars for a certain class of roads, and the experiment has reached a stage at which it deserves the attention of practical engineers in other countries.

The Luhrig motor car is built to accommodate 16 passengers seated within, with standing room for 5, besides the motor man on the front platform and 6 on the rear platform. Passengers are not allowed in Germany to stand in the aisles of street cars holding to straps. Under the American system of crowding and packing, one of the Luhrig cars would carry perhaps 40 people. Power is supplied by two double cylinder gas engines of 7 horse power each, located on either side beneath the seat and carefully inclosed in zinc sheathing, which excludes gas and smells and protects the machinery from dust and contact. Under the framework of the car are located at each end four cylindrical reservoirs, the whole eight having an aggregate capacity of about 360 cubic ft. of gas—sufficient to run the car 11 miles over a road in which the grades do not exceed 1 foot in 20. The cars weighs, without passengers, 7½ tons, and can be made for from $3,500 to $4,000, according to the number included in one contract. The cylinders of the engine are kept cool by water circulating through pipes leading from a cylindrical reservoir carried on the roof of the car, the heated water rising and the cold descending automatically, and with such satisfactory results that after a run of several miles the warmth of the cylinders may easily be borne by the naked hand.

Gas is supplied from the ordinary street mains, and is compressed to 8 atmospheres by a simple double barreled force pump worked by a stationary gas engine or other power, and at this pressure the reservoirs of a car may be filled through a flexible pipe in less than a minute. Gas costs in Dresden $1.05 per 1,000 ft., and, in view of the advantage which such a wholesale, all the year round consumption would offer to gas companies, it is safely assumed that most of them will be quite willing to erect compressing machinery at their own cost and deliver the gas to the motors at the prescribed density. The car is managed by one motor man standing on the front platform, who, with throttle and governor, regulates the speed at will from 150 to 240 engine revolutions per minute.

As the double engine gives a motive force of 14 horse power, a second car may be attached whenever needed, thus doubling the capacity of the line during hours or days of greatest activity. A loaded car climbs a grade of 1 in 15 at a speed of 4 miles per hour, but for satisfactory work in all weathers and seasons the grades should not exceed 1 in 20.

In an address delivered before the German Gas and Water Supply Association some weeks ago, Chief Engineer Kemper, of Dessau, submitted a comparative estimate for the construction and equipment with gas motor, electrical, and horse cars of a street railway 5 miles in length and requiring an outfit of 20 cars for ordinary service. In these estimates double tracks for all, two compressing stations at $2,500 each, sheds, etc., for the gas motor cars, are included; for the electrical roads, dynamos and overhead wires, and for the horse cars 120 to 150 animals, with the requisite stabling and fixtures, the intention being to show the comparative cost of building and putting into operation the same road under each of the three systems. The exhibit is as follows:

| | |
|---|---|
| Electrical ... ..... ..... | $180,880 |
| Gas motor ..... .. ..... | 142,800 |
| Horse cars ..... ..... ..... | 133,280 |

The original construction and equipment account is, therefore, slightly in favor of horse cars as compared with gas motors, though both are notably cheaper than the electric plant. But this difference in favor of horse power rapidly disappears when the cost of daily operation is taken into account. As the result of careful study, Mr. Kemper states the net operating expense of horse cars in Germany at 5½ to 7 cents per car kilometer, against 5 cents for electric cars and 4 cents for gas motor cars of the Luhrig model per car kilometer. There is thus claimed an economy in motive power of 25 per cent. in favor of gas as compared with electricity, and from 60 to 75 per cent. in comparison with horse power. It may be safely assumed that every town with area and population sufficient to require street car service has already a gas supply, and gas companies will everywhere be willing to favor this new and important outlet for their product by offering long contracts at favorable rates. Otherwise two or more street car companies could profitably combine and manufacture their own gas supply.

It is, of course, too soon to declare that the entire problem has been definitely solved, and no one will pretend that the Luhrig motors (which have undergone several improvements since being put into service) have reached or even approached the ultimate standard of utility; but the superior economy of gas motors over other means of propulsion for certain classes of tramways seems to be conclusively proved, and from this secure vantage ground whatever difficulties yet remain will surely be mastered.

## HIS EXCELLENCY SEÑOR DON LUIS CORDERO, PRESIDENT OF THE REPUBLIC OF ECUADOR.

DR. DON LUIS CORDERO, with whose portrait we adorn the columns of our paper, was born in what is now called the Province of Cañar, in the Republic of Ecuador, on April 6, 1833

In November, 1847, after having received primary instruction from his father and overcome many obstacles caused by his limited resources, he entered the Seminary of Cuenca, an excellent institution in which have been educated most of the notable men of the Department of Azuay.

He had scarcely concluded his academic studies when he was made secretary of this college, in which he served also at different times as professor of grammar, natural philosophy, mathematics and the humanities.

At the beginning of 1862 he obtained the degree of doctor of jurisprudence in the Universidad Central de Quito, dedicating himself to the exercise of his profession until the year 1867, when he entered business.

In this year he went to the national legislature as deputy for the Province of Azuay. It might be said that this was the beginning of the political career of Señor Cordero—of liberal modern principles, energetic in his opinions, indefatigable defender of public liberty, devoted to all progress, he attended several congresses of which he was a most notable member on account of his upright ideas and his great eloquence.

When the republican institutions were trampled down by the dictatorship of General Ventimilla, in the year 1881, Señor Cordero was one of the first to raise his voice against such scandalous usurpation; and when the patriotic forces that had risen in different parts of the republic for the defense of the constitution and laws took the city of Quito by force, the people of this capital—united in a popular committee—chose a pentavirato to take charge of affairs until the convocation of a national convention and the election of new public functionaries could take place. Señor Cordero was a member of this pentavirato.

In the year 1892, and after the sad death of General Don Francisco Jovier Salazar, Señor Cordero was nominated as a candidate for the presidency of the republic in the following constitutional period by the republican party, to which all of the most prominent men of Ecuador belong.

Elected president after a hard struggle, he followed in the footsteps of his predecessors and succeeded in preserving the peace of the republic. He has given especial attention to public instruction, but without neglecting the other branches of his administration.

Finally, when the question of boundaries arose between the governments of Ecuador and Peru, the Republic of Ecuador beheld the beautiful spectacle of all her sons united for the national defense; and this, which shows so clearly the patriotism of the Ecuadorians, also speaks well for the prudence and tact of Señor Cordero, who was then president.

HIS EXCELLENCY SENOR DON LUIS CORDERO, PRESIDENT OF THE REPUBLIC OF ECUADOR.

Although we have written this slight sketch of the career of Señor Cordero, it is impossible to have a complete idea of him if we consider only his political life.

The study of science and literature have always by preference occupied much of Señor Cordero's time, and his numerous poetical compositions and prose writings manifest the fruitfulness of the mind of him who is rightly known as one of the best poets of South America.

Señor Cordero is devoted to the study of the natural sciences, and has published several valuable pamphlets on the subject of the flora of Ecuador.

He is well versed in the Quichua language (the language of the aborigines of Chile and Peru), and has lately written a dictionary of this language which received a special premium in the Columbian Exposition at Madrid, in 1892.

The poetical compositions of Señor Cordero began to appear in the different literary periodicals of the republic after he studied the humanities.

The "Antologia de Poetas Ecuadorianos," published in 1892 by the Academy of Ecuador (which corresponds to the Royal Academy of Spain), of which Señor Cordero is a member, adorned its pages with his most notable composition, entitled "Aplausos y Quejas al inspirado Cantor de la Raza Latina, Don Olegario V. Andrade."

The distinguished Argentine poet, Don Olegario V. Andrade, in his "Atlántida: Canto al porvenir de la Raza Latina" (Atlantida: Song to the Future of the Latin Race), had forgotten Portugal, the republics of Central America and Ecuador. Señor Cordero, in the composition to which we refer, wished to repair the injury done to his country.

Many critics of high standing have compared the two compositions referred to, conceding the higher place to that of Señor Cordero.

The high tone, the sublimity of the expressions, and enthusiasm of this composition cause it to be considered one of the best products of South American talent.

## TELEPHONE RATES IN EUROPE.

THE following particulars about the rates for telephones in various countries may be of interest:

In Austria-Hungary the rates are uniform for all the state telephone exchanges. The state telephones cover the whole of the country, except the city of Vienna. The total charge is made up of an installation charge, which for a distance of not above 500 meters amounts to £5 (50 gulden), and for every additional 100 meters £1; then there is annually a station charge of £3, and what is called a working charge of £2, so that the annual charge is about £5.

In Switzerland the charge has been by degrees reduced to about £3 3s. (80 fr.) As a result of this low tariff the number of telephones has rapidly increased, and at the end of 1891 there were about 12,595 telephones.

In France the telephones are a state affair; the annual charge for towns with over 25,000 inhabitants is £8 (200 fr.) and for smaller towns £6 (150 fr.)

In Italy the telephones, in accordance with the telephone act of 1892, may be worked either by the state or by private enterprise. For the smaller and medium-sized towns the annual subscription ranges from £5 to £6.

Sweden boasts of an exceedingly well-managed and greatly developed telephonic system, which comprises both an extensive and ever-growing state telephone system and numerous private concerns. The rates are on the whole very reasonable; as a rule, a subscription of £4 10s. will cover an area of about a mile from the exchange. For smaller towns the rates are somewhat lower (£1 to £1 10s.) Private companies have as low annual subscriptions as £1 13s.

In Norway the subscriptions vary according to the size of the towns, but are on the whole moderate; they range, as a rule, from £2 4s. to £4 9s. It is at present under discussion to erect a very extensive system of state telephones in Norway.

In Spain most of the telephone companies are private concerns; the annual subscriptions vary considerably, say from £3 to £11.

In Holland, the Netherlands Bell Telephone Company has almost monopolized the telephones, and the subscriptions are fixed according to the size of the towns. In Amsterdam, for instance, the subscription is about £10 (118 gulden); in Rotterdam, £10; in

Grovenhagen, about £8 10s. (110 gulden); in Haarlem, Utrecht, Arnheim, Groningen and Zaandam, which are towns with something like 30,000 inhabitants, only £5 (60 gulden). In still smaller towns the annual subscriptions are reduced to £4 or £3 10s., and even these low charges are subject to further reductions by contracts extending over several years, etc.

The telephones of Belgium are partly state and partly private affairs. There are no uniform subscriptions, but the charges are registered according to the distance from the central station and the term of subscription. The charges for the state telephones are, for a distance from the exchange of one kilometer, £6. The usual charges for private companies vary from £5 to £6.

In Luxemburg the charges vary between £3 and £4.

In Denmark the Copenhagen Telephone Company, which through a state telephone cable has connection with Sweden, charges about £8 6s. 6d. (150 kr.) annual subscription. The subscriptions in the provincial towns vary considerably, from about £1 12s. 6d. to £4 4s.

In Germany the telephones are almost exclusively state institutions, and the charges are on the whole high.

In England, finally, the National Telephone Company charges from £20 annually in the city of London down to £10 or £8 in smaller towns.

## RIGHT AND LEFT SIGHTEDNESS.

IT is of course a well known fact that certain members of the body are inclined to be, as we say in speaking of the hands, right and left handed, but it is not generally known that the organs of vision are affected in this manner. That is to say, people who, while apparently looking with both eyes, use only the right eye or the left eye.

Manufacturers of fire arms, when making guns to order, carefully allow for the right or left sightedness of the sportsman. The gunmaker takes a card and pierces it with a hole one-half a centimeter in diameter; this card is given to the sportsman, who holds it thirty centimeters distant from the eyes and looks through the hole at a fixed point, Fig. 1. The hole and the point are always in a direct line with one of the eyes, with the right eye if the person is right sighted, with the left eye if the person is left sighted. To replace the hole and point to their original position, after being used by a person who is right sighted, the card must be moved to the left.

Figs. 2 and 3 show another form of the experiment which every one can perform. The experimenter who is right sighted tries to hide from both eyes with the index finger (without, however, succeeding, on account of the convergence of the visual axes) the face of a watch. Next he closes the right eye. At once his finger appears out of the line from his left eye to the watch face some twenty degrees.

It would be interesting to measure exactly the amount of the variations and reduce them to tabular form. The Marquis of Camaras, who has brought this subject to the attention of the readers of *La Nature*, says that out of twenty persons examined, two were left sighted, one being a woman. It would be particularly interesting to know if marksmen are left sighted. Women are more often left sighted than men, and when they are right sighted, they are so in a lesser degree than men. For the particulars given above and for the illustrations we are indebted to *Le Monde Illustré*.

## NICKEL—ITS HISTORY, USES, AND DISTRIBUTION.*

By A. G. CHARLETON, A.R.S.M.

### HISTORY AND USES.

THE subject of this paper is one which the author begs leave to present, thinking that it may be profitably considered. His own interest was awakened in nickel some years ago when making an inspection of an important group of nickel mines, and the works connected with them, in Germany, but the superior attractions of gold and silver mining have prevented him till now from reviving it. The discovery that nickel was a new element was made by Cronstadt in 1754, and he named it after the mineral kupfer-nickel, in which it was discovered by him, but it was reserved to Bergman in 1779 to show that nickel was really a new metal. Kupfer-nickel was described by Hierne in 1694, and its name indicates the low value set upon such ore by the German miners in those days. Kupfer-nickel, in fact, might be freely translated into English as "Old Nick's copper," the term nickel being probably derived from the Low German "nikker," which stands for the devil or hangman.

Deceived by the copper color of the mineral, the miners, no doubt, mistook it for copper ore, and probably gave it the name to warn future generations against what they, not unnaturally, regarded as a fiendish imposition on them; the miners, however, would, no doubt, tell you that it was due to the metallurgist's command of bad language, as they discovered that when cobalt ores became over-roasted in the manufacture of smalt the nickel they contained followed the former metal, and, combining with the silica, spoiled the blue color of the glass the makers wanted to produce. To quote a most instructive paper on nickel, read before the Colorado Scientific Society, December 4, 1893, by W. T. Austin, one may say that "Nickel has not received from scientific men the attention to which it is entitled, and the subtile influences exerted on the physical properties of its alloys by the admixture of exceedingly small quantities of other elements have mystified the practical man (so called by courtesy) and kept him in the background. For more than a century nickel puzzled and perplexed all who had anything to do with it, and its history is a long story of contradictory statements and mistakes." It seems to me it is a capital metallurgical illustration of the proverb, "Give a dog a bad name." But, granted so, a bad dog may sometimes be broken in, and become of service to its owners.

FIG. 1.—Instrument for Testing Right and Left Sightedness.

The literature dealing with the subject is exceedingly scanty, on the one hand because the properties of the metal have been insufficiently studied by those who would naturally be expected to investigate them from an economic point of view, and, on the other, because the interests of pure scientists in this field have for some reason lain dormant. Another cause is the secrecy maintained for so long a time by those manufacturing nickel products with regard to their processes and methods. This policy, which, it is to be presumed, has generally for its object the idea of deterring competitors from entering a special field, is surely a short-sighted one, as it may well be doubted whether manufacturers are ever benefited in such cases by jealously excluding the scientific discussion of their methods of treatment; experience in the rapid development of the iron and steel trades, in one instance, at any rate, going to prove the benefit of adopting an opposite policy.

Nickel has certainly maintained a high price in the past, but at the cost of an exceedingly limited consumption of the metal, and the original discoveries of ore in Scandinavia, Germany, and the United States furnished the trade for many years. It was only with the increased demand for the metal, induced by its more extended applications, that prospectors began to busy themselves and look around for larger supplies of ore, and the result has been the discovery of most important new fields, like those of New Caledonia and Sudbury, in Canada.

Austin traces four marked stages of development in the modern history of nickel.

1st. The century or more when the presence of some unusual metallic combination was recognized to exist in certain minerals, during which time the metal was introduced into the arts as an alloy known as "white copper," consisting chiefly of copper and nickel with a small proportion of zinc, closely resembling silver, tough, easily worked, and not tarnishable when exposed to gases containing sulphureted hydrogen.

2d. The period which commenced with the manufacture of German silver on a large scale at Berlin (about the year 1824), when nickel obtained a recognized position, Brandes having shown, the year previous, the exact composition of the new alloy.

Up to 1838, nickel was wholly derived from its arsenide ores, and it was not till then, when Berzelius is thought to have discovered nickel in the Klefva ores (Sweden), that Aschen made his first smelting experiments upon the nickeliferous pyrrhotites and pyrites of that country. The metallurgical losses were at first heavy, but between 1849 and 1851 Berdberg laid down certain principles, which have held good in nickel metallurgy up to the present time.

3d. The period which dates about this time (1850, when Switzerland adopted nickel for subsidiary coins) marks another era in the history of the metal. In 1888, it was first successfully alloyed with steel on a scale of commercial importance, and this has given nickel a fourth periodic impulse, which has only just practically commenced, and promises to far exceed all the preceding ones in its results. The world's production of metallic nickel has increased within the past ten years from 1,000 tons per annum to over 5,000 tons, while previous to 1876 not more than 600 tons were produced in any one year. As far as our knowledge at present extends, the principal value of nickel seems to lie in the properties of its alloys. For example:

(1.) German silver is of such general utility that articles made of it are everywhere to be found in household use.

(2.) Alloys of nickel and copper have largely supplanted the smaller silver coinage of several European countries and America.

(3.) A small percentage of nickel incorporated into steel has provided the engineer with a structural material superior, for many purposes, to the best carbon steel made.

(4.) Pure nickel, in the metallic form, is used for plating other metals, and though its cost is at present too high to admit of wide use, it is employed for making numerous small articles.

To give one instance only. A short time back the interest aroused in me by nickel, combined with the conviction that silver, under existing international currency conditions, at even 29⅜ an ounce, was an extravagant luxury, induced me to extend the application of nickel, by having a cap of it set on the handle of my old but valued umbrella.

Austen predicts that nickel will be put into the form of ferro-nickel, suitable for making commercial steel, at no distant time, in not more than three operations, without innumerable by-products being left over to work afterward. At present, the simplest and most direct method of treatment includes at least seven distinct stages—roasting, matting, Bessemerizing—after which it has to be "topped and bottomed," refined, reduced to oxide, and finally incorporated, not to mention all the side operations of working up the by-products. It is a subject, indeed, to which English metallurgists might, in all probability, profitably turn special thought.

Before the Christian era, nickel was employed for coinage purposes by the Bactrian king Euthydemos, 235 years B. C., and analysis of these coins shows that they were evidently intended to contain 22 to 23 per cent. of nickel to 77 or 78 per cent. of copper, closely approximating, curiously enough, the proportion of 25 to 75 per cent., which, experience has taught us, is the most desirable admixture of these metals for use in coinage. It is remarkable that Euthydemos hit upon this particular ratio of copper to nickel, and the fact that analysis shows no arsenic debars rich arsenical ores from being a source from whence the nickel employed was derived, and points to the use of sulphides, as the silicates could scarcely have been treated at that time. If this be so, it indicates considerable metallurgical skill on the part of the early smelters, and, considering the nature of the metals employed, it is hardly probable the alloy was a haphazard mixture.

Prof. Roberts-Austen mentions also that long before Europe awoke to the value of nickel, that enterprising person, "the Heathen Chinee," was making an alloy of nickel, and shipping it to Europe for a century or more, under the name of "Pack Fong,"* or "white copper."

Just before the commencement of the second period, before alluded to, nickel appears to have been discovered in the United States, when, in 1818, Seth Hunt opened the cobalt mines near Chatham, Conn., and shipped some of the ore to England, where it was reported upon and stated to contain nickel. These mines, in 1854, were said by Whitney to be the principal sources of American nickel, but from the fact that

* A paper recently read before the Society of Arts.—*From the Journal.*

* According to an analysis of a specimen in Dr. Percy's collection at South Kensington, composed as follows: Copper, 4·4 per cent.; zinc, 25·4 per cent.; nickel, 31·6 per cent.; iron, 2·67 per cent.

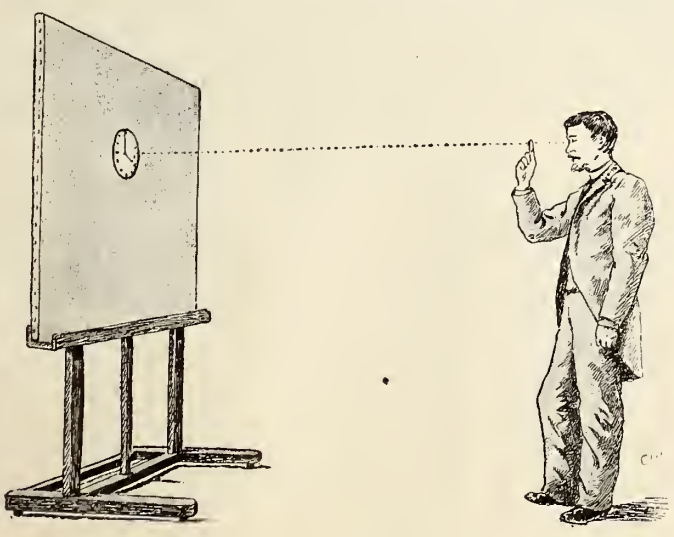


FIG. 2.—Disappearance of a Dial Behind the First Finger for a Right-sighted Person, the Left Eye being Closed and the Right Eye Open.

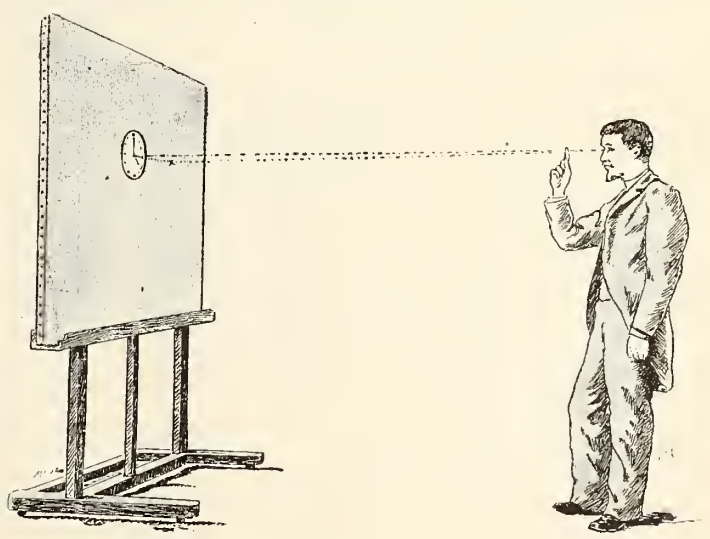


FIG. 3.—Apparent Deviation of the First Finger and the Reappearance of the Dial for a Right-sighted Person, the Left Eye being Open and the Right Eye Closed.

they were repeatedly taken up and abandoned, they no doubt proved commercially unremunerative.

The principal deposit of nickel opened to date in the United States, the celebrated Gap Mine, appears to have been discovered somewhat later, viz., in 1718, and was being worked for copper in 1744. It was not, however, till 1852, when the property came under new management, having proved unsuccessful as a copper "proposition," that investigations began to be made as to the nature of the yellow sulphide ore, looked upon as worthless mundic by the former owners, and thrown by them over the dump. The first tests were not conclusive; but, in 1853, Dr. Genth, of Philadelphia, pronounced it to be millerite. During the third period in the history of the metal, in 1862, Joseph Wharton acquired the Gap property, and put it into operation as a nickel producer, in May, 1863, starting a refinery at Camden.

At the Centennial Exposition in Philadelphia, in 1876, Wharton made an exhibit of nickel products such as had not been seen elsewhere up to that date; and in 1878 he showed articles made of pure nickel, both forged and cast, which were so remarkable that they excited at first considerable incredulity.

In 1804, Richter had succeeded in producing malleable nickel, but subsequent investigations met with very variable results, through neglect in recognizing the important part played by small quantities of impurities alloyed with the metal. A new future for nickel as a metal, apart from its alloys, dawned when, in 1879, Fleitmann found that by the introduction of small amounts of magnesium just before pouring, the quality of the nickel was improved, Garnier subsequently accomplishing the same end by the use of phosphor-nickel. This third period is likewise marked by the important event of the discovery, in 1876, of immense quantities of hydrated silicates of nickel and magnesium (garnierite) in New Caledonia, which placed an exceedingly valuable material at the disposal of manufacturers, opening up the possibility of producing a purer nickel from ores free from the usually accompanying deleterious substances, reducing the price of the metal, and extending its uses. Nickel ores had been discovered in the island some years previously, but it was not until 1876 that they began to influence the market. These new ores contained the nickel in the form of protoxide, free from cobalt, copper, sulphur, and arsenic, and, consequently, required an entirely different system of treatment from that by which the sulphide and sulpho-arsenide ores had been handled.

Some years previous to the appearance of the New Caledonia silicates at the metallurgical works of Europe, somewhat similar ores had been worked at Ickatarinenburg, in Russia, others were known to exist in Spain, and since then further deposits have been found in Oregon and North Carolina.

In 1876 the production of the Scandinavian mines reached its maximum height, the yield of Norway being 360 metric tons of metal, and that of Sweden considerably less than 100 tons. Since that date the production of this district has very considerably declined.

Nickel silicates were discovered in Douglas County, Oregon, in 1881, and have lately been exploited by an Anglo-American company, while in 1884 deposits of nickel ores were proved to exist in Churchill County, Nevada.

The Pacific Coast mines are said to be the most promising deposits at present known to exist within the boundaries of the United States, but distance from market, and the discovery of nickel in Canada, have militated against their development.

In 1856 Mr. Alex. Murray pointed out the occurrence of a dingy green magnetic "trap" at a point ten miles southwest of what is known as Sudbury, in Canada, and this rock, upon analysis, showed small quantities of nickel and copper.

The first discoveries of any commercial importance were not made until the building of the Canadian Pacific Railway, in 1883, and early in 1884, when a cutting on the line pierced a small hill about three and one-half miles southwest of Sudbury, exposing the deposit since known as the Murray mine.

In the spring of 1886, the Canadian Copper Company was formed to operate the Copper Cliff (Stobie and Evans' mines), but it was not till 1888 that the company erected their first furnace. Shortly afterward a number of companies entered the field, among others Vivian & Co., of Swansea. These Canadian mines, which are in the districts of Algoma and Nipissing, in the province of Ontario, have of late years attracted world-wide attention, first, on account of their apparently inexhaustible character; lately, because of the new applications of nickel in the manufacture of nickel-steel. One is apt to overlook nickel in its mineralized forms, and the Sudbury ore bodies were originally opened as copper mines.

The unusual properties displayed by meteoric iron, in regard to its extraordinary toughness, and in some instances its non-corrodibility, coupled with the fact that it is invariably associated with nickel and other elements, has of late years drawn attention to the influence which nickel exerts when alloyed. Faraday, Berthier, Longmaid, Liebig, Fairbairn, and Boussingault, Kunzel, and even Ledebur, all investigated the subject, but all efforts to manufacture a valuable alloy of iron and nickel were in vain until a few years ago, when the fourth era of nickel commenced; the trouble was that the immense influence of minute quantities of other accompanying metals and metalloids was unsuspected. Probably, the first appearance of nickel-iron alloys in the United States was when Philip Thurber, of Detroit, exhibited some products of the iron furnace at Marquette, Michigan, at the New York Exposition in 1853 This iron was made from a nickeliferous limonite, and possessed some remarkable qualities, but it was not till 1888, after experiments had been made by Marbeau in France, with crucible nickel-steel alloys, that James Riley took the subject up, and began experimenting in Scotland with similar manufactures, produced in the open hearth, and convinced himself and the metallurgical profession of the genuineness of the claims advanced for this new material. The results are given fully in a paper read by him at the Glasgow meeting of the Iron and Steel Institute, May, 1889.

Notable among these was an alloy containing 4·7 per cent. nickel, which showed an elastic limit of 28 tons per square inch and a breaking strain of 40 tons, whereas similar steel without nickel showed only 16 tons and 30 tons, respectively. The elongation and contraction of area of this steel were not moreover materially impaired. In a series of competitive armor trials, made at Annapolis, Maryland, in September, 1890, the palm was awarded to a French nickel-steel plate, and Mr. Tracy, at that time Secretary of the United States Navy, gave orders to have further trials of similar material made, which had been manufactured of American material by American mills, with a view to decide the best material for protective armor for the new men-of-war being built. These tests, as reported by Mr. W. S. Abbott, of Carnegie, Phipps & Co., gave an ultimate tensile strength of 100,000 to 102,000 pounds per square inch, with an elastic limit of 59,000 to 60,000 pounds. The elongation was 15½ per cent., with a reduction of area of 29½ and 26½ per cent. respectively at fracture.

The toughness of nickel-steel is shown by the fact that blocks cut from the armor plates at Bethlehem, many of them weighing several tons, cannot, by any method yet devised, be profitably broken up into sizes suitable for returning them to the furnaces. It is stated also that experiments lately made by the German government show that shells exploded in ordnance made of ordinary steel badly injured it; while with nickel-steel, it was only enlarged. New York *Engineering and Mining Journal*, March 11, 1893: "Ordinary gun steel contains 0·3 to 0·5 of carbon, and may contain 0·8 of manganese."

One by one objections raised against nickel-steel have been removed, the effect of cold weather on the plates, for instance, having been experimentally demonstrated to be of no consequence, if one may judge from a series of experiments carried out at the United States navy yards since 1891.

The tough, tenacious material flows under the impact of the shot, and in the case of "Harveyized," *i. e.*, surface hardened plates, the extreme hardness of the exterior, reinforced by the tough untreated steel behind, shatters the forged steel Holtzer projectiles, which have hitherto proved irresistible.

These shells are made, I believe, of highly carbonized steel, containing 0·8 to 0·94 of carbon, and, in addition, 0·94 to 2 per cent. chromium. Nickel-steel is practically incorrodible, and can be advantageously made on the basic, open hearth furnace. Professor Roberts-Austen, p. 48 of his valuable "Introductions to the Study of Metallurgy," states that nickel has an atomic weight of 58·60, atomic volume of 6·7, specific gravity of 8·80. specific heat, 0·110, melting point, 1,600, coefficient of linear expansion, 0·0000727, electric conductivity, 7·374. Quoting the investigations of Riley, he gives a diagram, which shows that nickel up to 7 per cent. materially increases the tensile strength of steel and its elastic limit, while its extensibility is as rapidly diminished.

Though there has been no material increase in the established channels of consumption, except it be for plating, while 1,000 tons of nickel flooded the market in the early years of the century, 10,307,275 pounds, or, roughly, five times as much, was produced in 1891, consequently the large excess of metal produced must have gone into nickel-steel, yet this alloy has scarcely begun to be used in the arts of peace. As its price tends steadily downward, we may confidently expect that it will eventually enter into competition with other materials for other purposes than armor plates and guns. Though there is always naturally some hesitation in adopting a comparatively untried material, where it is subjected to extremes of temperature, such as for boiler plates, bridge building and marine engineering, experiments are going on all around us, and last year it was decided to place sections of nickel-steel propeller shafting in the United States protected cruiser Brooklyn* and the battleship Iowa. The ordinary carbon-steel used for such purposes has a tensile strength varying from 60,000 to 65,000 pounds per square inch, whereas the nickel-steel will show a tensile strength of 90,000 pounds per square inch, the elongation in both cases being about the same, 20 per cent.

Using this stronger steel will warrant boring out the shaft, materially lessening the weight while preserving its efficiency, and such cored shafting can be hollow forged when the hole is large enough to admit a mandril.

If it is found possible to apply it to the construction of boilers, the tensile strength of nickel-steel being 1½ times that of ordinary steel, it will enable their thickness to be reduced one-third, effecting a saving in weight, which is often a great consideration. Jules Garnier gives in *Le Genie Civil* the results of a series of tests made in 1892, at the Cleveland Rolling Mill Company's works, on nickel-steel. The nickel was produced at the Brooklyn Nickel Works, from Sudbury ore, by the Canadian Company. The comparative results of these trials, by the side of others on ordinary steel made and tested under identical conditions, are given in the New York *Mining Journal* of February 25, 1893, and the deductions drawn from them were:

1. Nickel-steel has a higher elastic limit of some 11,400 pounds per square inch, or nearly 31 per cent. more than ordinary steel.

2. The tensile strength of nickel-steel is greater by some 10,400 pounds per square inch, or an increase of about 20 per cent.

3. The ductility of steel is not reduced by the presence of nickel.

During last summer the Bethlehem Iron Works completed a spare crank shaft for the American liner Paris, using nickel-steel of about 90,000 pounds T. S., which is said to be 25,000 pounds in excess of any German or English manufactured steel, with the exception of the material turned out by one firm in this country, which has adopted steel of a similar character. Another important channel of consumption is the manufacture of a nickel-copper alloy (Ni 20 per cent., Cu 80 per cent.), for casing bullets to be used with small bore rifles now adopted by all the armies of Europe. This alloy has a higher degree of tenacity than the best brass, combined with a higher coefficient of elongation. The possibilities opened up by the uses to which nickel alloys may be applied by engineers in different branches of business may well attract the attention of miners and capitalists to deposists from which supplies of the metal can be got. The ores of nickel include the following minerals:

* New York *Engineering and Mining Journal*, November 26, 1892.

*Sulphides.*

| | Nickel, per cent. |
|---|---|
| Millerite, NiS | 64·6 |
| Polydymite, $Ni_4S_5$ | 59·4 |
| Beyrichite, $Ni_3S_4$ | 54·2 |
| Pentlandite (FeNi)S. | 34·0 |

*Arsenides and Sulpho-arsenides.*

| | |
|---|---|
| Niccolite, NiAs | 43·9 |
| Rammelsbergite and cloanthite, $NiAs_2$ | 28·1 |
| Gersdorffite, NiAsS | 35·4 |

*Sulpho-antimonides.*

| | |
|---|---|
| Breithauptite, NiSb | 32·8 |
| Ullmanite, NiSbS | 27 8 |
| Wolfachite, Ni(AsSb)S | 29·8 |
| Coryite, Ni(AsSb)S | 28·8 |

*Silicates.*

| | |
|---|---|
| Genthite, $2NiO.2MgO.3SiO_2.6H_2O$ | 22·6 |
| Garnierite, $H_2(NiMg)SiO_4 + Ag$. | 25·0 |
| Connarite, $H_4Ni_2Si_3O_{10}$ | 31·4 |
| Rewdanskite $(NiFeMg)_3Si_2O_7 + 2H_2O$ | 28·1 |

*Sulpho-bismuthide.*

| | |
|---|---|
| Kallilite, NiBiS | 19·0 |

*Telluride.*

| | |
|---|---|
| Melonite, $NiFe_3$ | 23·8 |

*Oxides and Salts.*

| | |
|---|---|
| Bunsenete, NiO | 78·5 |
| Nickel oxide, $Ni_3O_4$ | 73·1 |
| Morenosite, $NiSO_4 + 7H_2O$ | 20·9 |
| Annabergite, $Ni_3As_2O_8 + 8H_2O$ | 29·4 |
| Cabrerite $(NiMg)_3As_2O_8 + 8H_2O$. | 25·1 |
| Forbesite, $H_2(NiCo)_2As_2O_8 + 8H_2O$ | 14·4 |
| Lindackerite, $3NiO.6CuO.So_3.2As_2O_5.7H_2O$ | 12·9 |

*Carbonate.*

| | |
|---|---|
| Zaratite, $NiCO_3.2Ni(OH)_2 + 4H_2O$ | 46·8 |

It may be mentioned that millerite has been found in Iowa, forming tufts of beautifully arranged needles, in large, perfectly transparent crystals of calcite, in the compact lower carboniferous limestone of the Keokuk quarries, some 20 feet below the "geode-bed;" in cavities running up 20 inches in length, thickly set with rhombohedrons of this peculiar character.

*(To be continued.)*

[Continued from SUPPLEMENT, No. 962, p. 15375.]

## THE ADULTERATION OF FOOD.*

By H. W. WILEY, Chemist of the United States Department of Agriculture.

IT is hardly patent to this lecture to refer to foreign countries, but it may be said that in general the best laws in this country, national and federal, are based on the English food and drugs act, which is entitled an act to make better provision for the sale of food and drugs in a pure state. This became a law on the 11th of August, 1875.

The laws of the continental countries of Europe are also in the main effective, but contain such a multitude of minutiæ as would render them very burdensome if enacted in this country. The English law has been in operation long enough to prove its efficiency, and under it hundreds of convictions for the sale of impure foods and drugs have been secured.

The Canadian law is essentially the same as that of England, although not so comprehensive.

The States not heretofore mentioned have, so far as could be ascertained, no laws relating to the adulteration of foods. At least they were not reported, although inquiries were sent to the Secretary of State of each State in the Union for information in regard to this matter.

Many municipalities also have local laws applying to the sale of adulterated foods. These laws are mostly of a specific nature and apply chiefly to dairy products. There would be no time here to even mention the cities having local laws on this subject, but there are now very few large cities in the country which do not at least have some kind of milk inspection.

Lying at the root of the question of food adulteration is the inquiry, What is meant by pure food? In the laws which have been enumerated, attempts have been made to legally decide what pure food is. Divested of all legal technicality, pure food is a wholesome article of food or drink which is sold and consumed under its proper name. With each particular article there must be established a separate standard which a consensus of experience with a great number of known pure substances in that list shows to be required. For instance, take the case of milk, which is one of the most common articles of food, and perhaps has been more generally adulterated than any other one. Analyses made all over the world on hundreds of thousands of samples of healthy cow's milk have shown that the average content of solids therein is practically nearly 13 per cent. A normal milk which falls below this standard shows some peculiarity in the animal giving it, either an incipient disease, deficient nutrition or some idiosyncrasy. The mixed milk of a herd of healthy animals will rarely fall below this standard. For this reason the standard of 12½ per cent. of total solids in milk has been adopted in most countries having laws on the subject. In some cases the benefit of the doubt is given to the vendor and a standard is fixed at 12 per cent.

Now, of these total solids a certain quantity in normal milk must be butter fat. It is not often that the butter fat of a perfectly healthy cow's milk falls below 3 per cent. of the total weight of the milk. It is much more apt to be 3½ per cent.; hence, in fixing a standard of pure milk not only must the percentage of solids be given, namely, 12 or 12½ per cent., as the case may be, but also the quantity of fat contained therein. This percentage varies in different laws, from 2¾ to 3½ per cent.

In a similar method the standard of purity of any other article of food must be determined by a careful

* A lecture delivered before the Franklin Institute. From the *Journal of the Institute.*

examination of pure samples from all quarters, and by then fixing a standard below which an article must be regarded as suspicious or adulterated.

As a distinction between a pure and an adulterated article, take the cases of butter and oleomargarine. Pure butter, for instance, must be clean, sweet, wholesome and made of the fat of cow's milk, and must contain only a certain proportion of water, curd and salt. Oleomargarine may be as sweet, clean and wholesome as the butter mentioned above, yet when sold as butter it is clearly not pure food, but a spurious article.

Again, when the housewife buys lard it is supposed that the article she obtains has been made from the fat of healthy, freshly slaughtered hogs, carefully selected and cleaned and rendered in clean kettles or tanks. Cotton-seed oil and beef tallow, in respect of cleanliness, nutritive properties and wholesomeness, may equal and even excel pure lard, but the admixture of these articles with hog's lard, or their sale as such, without the knowledge of consumers, is clearly a fraud and an adulteration.

From a practical point of view, food adulteration may be considered under two general aspects, namely:

(1) Adulteration harmless to health and practiced merely for cheapening the article or making it more attractive to the sight or taste.

(2) The addition to a food or drink of substances positively injurious to health.

Such substances are added chiefly as preservatives or for the purpose of coloring or decolorizing, or for the purpose of giving a particular flavor or taste. As a rule, they are added in minute quantities. In fact, the proportion of such substances is usually so small that a moderate or intermittent use of food so treated may not produce any great injury to the system. The continued use of such articles, however, must end in the impairment of the general health and sometimes in permanent injury.

In the latter class of adulterations must also be included those injurious substances naturally arising from the decay of wholesome foods, or from the development of noxious substances in canned foods, or from the formation of poisonous salts by the action of the canned foods on the solder and tin of cans. Such materials, while not intentionally added, are, nevertheless, adulterations within the true scope and meaning of the term as applied to foods. In other words, it is not necessary to prove intent in order to establish the fact of adulteration. Any food which is not what it purports to be, which contains any unwholesome or poisonous ingredient, or which has any artificial coloring or facing material, is, to all intents and purposes, adulterated.

There is one legal exception to the above classification, namely, the use of annatto in coloring butter. The national oleomargarine law, applied to the Territories, the District of Columbia and to interstate commerce, permits an artificially colored butter to be passed as genuine, and I believe most State laws referring to this subject contain the same provision. Indeed, in some States oleomargarine exposed for sale is required by law to be stained pink or some other color distinctive from yellow, and such a stain, while an actual adulteration, could not be classed as illegal.

There is still another form of fraud in food which may be defined as a negative adulteration. It consists in extracting from a food part of some valuable ingredient, and selling the residue as the genuine article. The sale of skimmed milk for whole milk and of spent tea leaves for genuine leaves are illustrations of this kind of fraud. Perhaps the best method of illustrating these various kinds of fraud and adulteration will be to call attention to some of the articles sophisticated in the ways described. No attempt, however, will be made to give a complete list of adulterated articles, for such a list would fill a volume. Attention, therefore, will be called only to the more important articles of food, and to those which are most commonly adulterated. In addition to this, examples will be given of some peculiar forms of adulteration which are little known to the public.

*Milk.*—Normal cow's milk should contain about three and one-half per cent. of butter fat, and should yield, on standing in a cool place for twenty-four hours, from ten to twenty per cent. by volume of cream. Until the establishment of milk inspection in cities, whole milk was something of a rarity. With careful inspection, such as obtains in Boston, the percentage of adulteration has been largely reduced.

An ingenious method of milk adulteration is sometimes practiced by the shrewd husbandman in such a way as to preserve his tender conscience from being seared. The cream in the cow's udder is naturally separated in part from the milk, unless the cow, just previous to milking, be subjected to violent exercise. The first milking, therefore, is less rich in butter fat, and it can be sent directly to the consumer. The last of the milking, called strippings, on the other hand, is nearly pure cream, and can be preserved for butter making. Butter fat being lighter than whole milk cannot be removed without increasing the density of the remainder above the normal. This density, however, can be reduced to the proper limit by the judicious addition of water. The testing of milk by the lactometer alone is, therefore, not a certain method of discriminating between a pure and an adulterated article.

Condensed milk is made by evaporating whole milk at a low temperature and in a high vacuum, in copper vessels, yet even at this low temperature some of the distinctive aroma of the milk is carried off by the escaping vapors. It, therefore, happens that even when evaporated milk is diluted to its original volume with water, it is never exactly itself again. Yet a pure condensed milk is not an adulterated article, for it is sold as condensed milk, and hence no fraud is practiced. When, on the contrary, as is often the case, sugar or salicylic acid is added, in order more securely to preserve the condensed product, then a perfect case of adulteration is established. The manufacturer, however, may relieve himself of all responsibility, in so far as the addition of sugar is concerned, by stating on the label the amount added. In cases of deleterious preservatives, however, there would be no excuse. Their use in all cases should be prohibited.

*Butter.*—In regard to butter, the character of adulteration is well known. The use of oleomargarine as a butter substitute has been practiced for many years. The oleomargarine law, which imposes a tax of two cents a pound on the manufactured product, has not helped to restrict its use, but has rather increased it by giving to the consumer a guarantee of purity. The amount of tax collected on manufactured oleomargarine for the fiscal year ending June 30, 1892, was $945,675, which shows that there were 47,283,750 pounds of oleomargarine manufactured in the United States in twelve months.

The number of retail dealers in oleomargarine increased during the year more than 25 per cent. over the preceding year. The amount of tax paid by retail dealers for the fiscal year ending June 30, 1891, was $146,293.70, and for the fiscal year ending June 30, 1892, $204,215.

The increase in the number of wholesale dealers was nearly 100 per cent. The amount of tax paid by wholesale dealers for the fiscal year ending June 30, 1891, was $53,191, and for the fiscal year ending June 30, 1892, $106,036.

There can be no reasonable objection to the use of oleomargarine; it is clean, wholesome and digestible. When it is to be kept for a long time before use, as on ship board or in distant mining camps, it is preferable to butter, because it has but little tendency to become rancid.

*Lard.*—For similar reasons there can be no possible objection to the use of cotton-seed oil as a substitute for lard or when mixed with lard, provided it be sold for what it is. Most of you are familiar with the great fight which was made against the use of the term "pure refined lard," which was the trade name of a mixture of lard stearine with cotton-seed oil. "Pure refined lard," it was claimed, was a term which had been used so long to designate the mixed product that it had become in reality a trade mark, and was, therefore, entitled to respect and protection. In the investigation which was held before the Congressional committees, it appeared that as to the trade the contention was quite justifiable. Goods sold under that name were understood to be mixed. When, however, the mixed product was offered to the consumer, it was purchased with the idea which the name naturally implied, that an extra fine quality of hog's lard was secured.

All attempts to pass a pure lard bill, modeled on the oleomargarine act, have heretofore failed in Congress, but several of the States have prohibited the sale of mixed lard, except when offered under the proper name. Manufacturers have, therefore, been gradually forced to abandon the term "refined lard" when applied to this commodity.

I am of the opinion that many persons would prefer a cooking fat largely of vegetable origin to a pure animal product. To me, it seems that some State legislatures have taken a reprehensible course in prohibiting the sale of vegetable oils as a substitute for lard for cooking. The grower of hogs undoubtedly has a right to contend against the sale of vegetable oils as hog fat, but when he pushes his claim still further, and demands that the markets be closed to products as pure and nutritious as his own, he passes beyond the bounds of public support. Every person in the United States who prefers cotton oil to lard should be allowed to purchase his supplies without let or hindrance. Every grower and maker of pure lard has the right to an equally open market from which every adulterated and mixed lard offered as pure should be rigidly excluded.

For a time, a few years ago, when a popular fad prevailed in favor of nitrogenous foods, the true value of fats to the digestive and nutritive economy was not well appreciated. At the present day this is all changed, and we know how to value a fat properly.

It is, therefore, a matter of no mean importance to protect the public in the use of olive oil instead of cotton oil, of cotton oil instead of lard, and lard instead of a mixture of beef and cotton oil stearine. It is true that cotton oil, when carefully refined, is almost as good a salad dressing as olive oil, but it is very much cheaper, and those who prefer to pay the high price should be secured against fraud. In respect of wholesomeness and digestibility, it would be hard to choose wisely between the two.

One of the great difficulties in securing the enactment of a national pure food bill has been the feeling in cotton-growing regions that such a bill would restrict the market for cotton oil. This is true, if the fraudulent market is meant. By that I mean the surreptitious sale of cotton oil as olive oil and as lard. But such a bill would not interfere in the least with the legitimate market for this product. Cotton oil, as a food, has such merit of its own as to warrant the belief that it does not require any smuggling to secure for it a wide and rapidly increasing use. The South as well as the North would be the gainer from honest markets for honest foods, and it is a shortsighted policy that leads to a crusade against such legislation as will secure the desired result. It would be a rather unfortunate thing for the whole country should an irrepressible conflict between the *sus* and the *gossypium* keep our interstate market forever open to mixed or doubtful fats.

(*To be continued.*)

## HOTEL HYGIENE.

AT a recent meeting of the Société Normande d'Hygiène Pratique, M. Percepied read a paper on the transmission of infectious diseases in hotels, where the bedrooms are occupied in turn by invalids and healthy persons. (*New York Medical Journal.*) It is principally in reference to the watering places or the winter resorts that the attention of physicians and of the public has been aroused, he says, and in a number of resorts the suggestions mentioned in this paper have been adopted and have given rise to reforms, still in their infancy, but destined to extend rapidly. It is a great mistake, in his opinion, to limit hygienic precautions to health resorts only; all hotels, whatever they may be, should have the same rigorous care. The condition of health of the people received at these hotels is not known, and, granting that acute infections diseases are relatively rare, it is certain that invalids with chronic diseases, such as tuberculosis, are frequent patrons, and the fact that the majority of the travelers remain only a short time cannot be brought forward as an argument. They have the right to remain as long as they please, and they also have the right to demand that all sanitary precautions shall have been taken in the rooms that they occupy. The subject under discussion applies only to travelers, although there is much to be said with regard to hotel kitchens and lavatories, and, above all, to the condition of health of the cooks and the other employes who live there. M. Percepied confined himself to saying that kitchens should be provided with draught flues, and be sufficiently well ventilated for the odors not to pervade the hotel. Infectious diseases are due to germs that are very unyielding and retain their virulence for a long time, and these germs may be in every part of a room that has been occupied by an invalid; in the bedding, as well as on the walls or on the floor. Knowledge of these facts imposes the necessity of modifications in order to render the rooms habitable and free from danger to those occupying them. First of all the room should afford air in proportion to the number of persons occupying it, and should be well ventilated and sunny, for the importance of sunlight and air as hygienic factors is well known. The walls should be hard finished or coated with an impermeable paint which can be washed, and, so far as possible, all corners should be rounded to make them accessible to washing. Moldings, unless rounded, should be discarded. Carpets should be rigorously prohibited, and a parquet floor, which can be washed, substituted, or a covering of linoleum of an artistic and pleasing design used. An advantage to be gained by this is the abolishing of the spaces which always exist between the boards of an ordinary wooden floor. If the traveler desires to be more comfortable, he can have a movable carpet or rug, on condition that after his departure it is beaten and passed through a disinfecting bath before it is used again. The same precautions should be taken with regard to carpets. In rooms that are not very much used a heavy linen covering can be substituted for carpets, which can be sent to the wash like clothing. For the same reason curtains should not be tolerated, except those that can be washed. White ones are preferred, as the monotony can be relieved with a border of embroidery in bright colors. Heavy materials, like plush and velvet, should never be used. The furniture should be very simple in design, so that it can be cleaned easily. Wooden furniture, wardrobes, bureaus, and toilet tables should be varnished or waxed, or, if preferred, lacquered. Chairs should have caned bottoms. Thus it is possible to conform strictly to hygienic laws, and at the same time preserve an artistic appearance. Everywhere, where it is possible, brass or iron bedsteads should replace those of wood. Toilet articles, especially the glasses, should be washed every day with the greatest care. After the departure of a patron they should be washed in an antiseptic solution, such as a half per cent. solution of corrosive sublimate, and the bedding, towels, etc., boiled in alkalinized water. With regard to the means of lighting hotels, electricity is to be preferred, although that is a question of secondary importance. The heating should be with wood, coal, or coke. After a room has been occupied by an invalid, all the bedding and other linen should be sent to the disinfecting bath, and the walls, boards, and furniture submitted to antiseptic washing and antiseptic spraying. These precautions should not only apply to the bedrooms, but extend to the different rooms that the patrons have used, although with less strictness. The curtains of the parlors, where they remain but a short time, do not require such rigorous treatment. Nevertheless, draperies should be avoided and carpets prohibited. The same precautions should be observed in the dining room. Here particular care should be given to the washing of the glasses, the forks, and the spoons. The former, after each meal, should be washed in an antiseptic liquid, and afterward well rinsed in clean water, and the latter in boiling water. The vestibules, halls, and stairways should be without carpets and should be wiped every morning with a cloth wet with an antiseptic liquid. The closets should be large and well ventilated, and have proper appliances for flushing. These precautions should extend to the rooms of the employes, where the sanitary conditions should be under the strictest surveillance. As soon as a case of sickness is discovered isolation should be practiced, in order to take the necessary precautions as regards disinfection. These are the measures, the author says, which should be resorted to at the present time, and failure to do so shows a culpable indifference. At first it may seem that these precautions would be a source of expense to the hotel keepers, but the abolishing of curtains, carpets, and furniture covered with rich silks and velvets will prove economical for them in the end, and, if they are properly carried out, any danger of infection will nearly always be averted.

## SOME THOUGHTS ON PHARMACY AS A PROFESSION.*

By SAML. P. SADTLER, Ph.D., Professor of Chemistry.

IT is estimated that there are at present some 40,000 druggists in the United States. Now, if we had an army of 40,000 trained and experienced veterans and the question was as to the addition of some 600 new recruits (supposing that to be the number of graduates this year from the different colleges of pharmacy), we would not entertain the idea for a moment that such an addition could exert any notable influence. But if we consider the responsibilities attaching to the work of a pharmacist, its close relations to the practice of medicine and the fact that the issues of life and death often depend upon the skill and accuracy of the compounder of medicines as well as upon the learning and judgment of the physician, and then reflect that of these 40,000 druggists not over 8,000 at most have had the education of a school of pharmacy, the case presents a different aspect. We must then look upon the strengthening of this educated element among the druggists by some 600 new recruits, freshly drilled in the most recent advances of science and the results of the best methods of manipulation, carefully gathered for them by able and experienced instructors, as a very important matter. It is the sending out of new leaven which shall work through the whole body of practicing pharmacists, strengthening what is good in it

* Abstract from the valedictory to the class of 1894, Philadelphia College of Pharmacy.

and exerting influences that may in time be powerful and far-reaching.

The recurrence of this annual event, the commencement of full professional activity for the large body of young men now before us, we believe this has some importance for the profession into which they are about to enter. At the same time it gives us an opportunity to pause for a few minutes and look at the condition of the profession of pharmacy, to consider some of the drawbacks to its prosperity existing at present, and to consider suggestions for its improvement.

The profession of pharmacy is a peculiar one. It differs in important respects from the so-called learned professions of law and medicine, not in requiring less, for a competent pharmacist must be well grounded in quite a range of the sciences, but in the peculiar conditions under which it is practiced. It is considered unprofessional for the lawyer or the doctor to advertise, but the pharmacist is a vender as well as a professional man, and is expected to bring his wares to the notice of the public.

And just here arises the first danger to him as one who has a profession, for the practice of which he has been educated. It is to lose sight of the fact that if he is a professional man he must be content to rise slowly as the young lawyer or doctor does, to enlarge his circle of patrons gradually, but gaining their respect at the same time and holding it. He is tempted to look at the purely mercantile side of his position and to stoop to claptrap methods of drawing attention to himself and his store. This is said to show American "push" and "snap," but certainly there ought to be some other outcome than that from the years spent in acquiring a professional education. He may get the name of a "hustler," as it is termed, but does it not appear on closer inspection that such a reputation is gained in most instances at the expense of professional standing?

The methods of rush and push, of turmoil and struggle, have, I fear, completely taken control of most of the mercantile communities in our American cities and large towns; but would it not be better for the educated pharmacist to aid in keeping such methods out of pharmacy and by avoiding catchy efforts to attract trade, dignify his profession and his own standing in the community?

Of course it will be said, and with some truth, that in large cities especially, the competition is so great that the newcomer is obliged to push himself forward in order to get a foothold; that if he does not, he will be left behind, will starve, it is often said. But a man of good sense can soon see a difference between proper commendable enterprise and the unprofessional and sensational efforts to push one's self into notice, of which I have just spoken.

Again, the invasion of the apothecary's field by the patent medicine man and the cultivation and solicitation of the physician directly by the manufacturing druggist are drawbacks which the pharmacist has to contend with. But is it not the mercantile rather than the professional side of his activity that suffers, and is it not true that, in proportion as he has developed the professional side, he suffers less from these difficulties?

In other words, if he has become known as a skillful and able pharmaceutical chemist himself, who has kept up with recent progress in chemistry and pharmacy, he will suffer notably less from such drawbacks than if he had staked all his success on attracting attention to his store by advertising novelties.

Another of the drawbacks to the proper recognition of pharmacy as a profession is the comparison so often drawn between it and the related profession of medicine, and drawn, I need hardly say, in most cases to the disadvantage of the former. It is not alone drawn by the doctor, who from the time he leaves the medical college calmly draws a line between himself and the laity, as he calls the rest of the world. This superiority of the medical profession is too often conceded as a matter of course by the pharmacist, who feels the necessity of gaining the good will of the medical profession living in his neighborhood as a question of business. Is it any wonder, then, that the public take him at his own estimate and grow accustomed to give a respect to the one profession that they deny to the other? This difference in valuation is only encouraged when the pharmacist proceeds to demonstrate his belief in it by taking up medical studies, even after years of practical business life, and adding the medical degree to that of graduate in pharmacy. I do not wish to be misunderstood here. Many young men enter upon the study of pharmacy and pursue it diligently with the full intention from the beginning of following it by studies in medicine. For such a plan I have nothing but commendation.

I have repeatedly heard medical men, who had pursued this plan, acknowledge the invaluable aid that the thorough grounding in a knowledge of drugs and medicines and their preparation acquired in a college of pharmacy gave them in the after practice of medicine.

But cannot the graduate in pharmacy, who has had no such plan of study, who has only started out to acquire a pharmaceutical education, feel that he has a worthy profession before him, if he will but strive to make himself worthy of it? He has had an insight during his college years into the methods of work in chemistry, both analytical and synthetical, in operative pharmacy, the field of which is becoming wider every day, in microscopical study of plant tissue and drug structure. Is there, then, nothing that promises results for him in all this—results that will bring him both pecuniary reward and reputation?

I am not saying that, if he devote himself somewhat to these things, he will thereby come to the reputation of a Liebig in chemistry, or a Procter in pharmacy, or a Maisch in his knowledge of materia medica. But he will raise the standard of his profession and will be honored individually in having contributed to this result. Nor will the result be empty glory.

If the pharmacist is known to his neighbors and to the medical profession with whom he comes in contact as a good chemical analyst, a thorough botanist and pharmacognocist, and, above all, a skilled compounder of all classes of official pharmaceutical preparations, he can rest assured that he will succeed, if he has, in addition, good common sense. Of course all of these educational qualifications referred to may be thrown away on a visionary, rash and unpractical person.

[FROM NATURE.]

## THE ARCTIC EXPEDITIONS OF 1894.

IT is not easy to speak definitely regarding the various Arctic expeditions which will be in the field this year, for several of the most loudly advertised ventures have collapsed or been postponed, and it is possible that some quiet and determined explorers may set out without calling public attention to their plans. There is undoubtedly to be keen rivalry in the North Polar basin for several years to come, and even an incomplete forecast of the projected work may serve to direct notice to the regions whence good results in the way of Arctic discovery may be looked for. It is unnecessary to insist in the pages of *Nature*, however needful the caution may be to the general public, that no credit for Arctic exploration can be given until the intending explorer returns, bringing with him proofs of his achievements which will bear the keenest criticism of experts.

Two well equipped expeditions have been in the field since last summer, working by different methods, from different sides, but both led by men of experience and manned by tested Arctic travelers. Nansen's expedition in the Fram appeals most powerfully to the imagination for the boldness of its plan and the faith with which its leader bases his success and even his life on the truth of his theory of ocean currents in the far North. The general trend of these currents, as drawn by Dr. Nansen, is shown on the accompanying map, which is reduced from one published in the *Geographical Journal*, vol. ii. His strongest evidence for the existence of a drift across the center of the polar basin was, as is well known, the discovery on the ice off the south of Greenland of relics from the American exploring ship Jeannette, which sank off the New Siberian Islands; but this was fortified by much additional information. The Fram sailed from Christiania on June 24, 1893, passed through the Waigatz Strait on August 3, and the last news was that on August 6 some Samoyeds saw her passing along the Yalmal coast between the ice and the land. Nansen intended to call at the mouth of the Olenek River in September before turning finally northward, but he did not do so. If he had called, or even been sighted off the coast, the fact would have been reported to Baron Toll, who was in the neighborhood of the Olenek until November. It seems probable that, making an easy passage across the Kara Sea, Dr. Nansen found sufficiently open water to induce him to turn northward off Cape Chelyuskin, as he was urged to do by Captain Wiggins, and that the Fram has passed the winter fast in the ice somewhere within the 80th parallel, possibly drifting poleward. No news can now be looked for by way of Siberia, and it is very unlikely, though just possible, that one of the expeditions going north this year, by Franz-Josef Land or Spitzbergen, may meet the crew of the Fram, where all the meridians converge toward the pole.

Mr. Peary, after raising the necessary funds in America by writing and lecturing, returned to the scene of his former triumphs at Independence Bay on the northeast coast of Greenland. He and his party landed at Bowdoin Bay, on Inglefield Gulf, in Smith Sound, on August 3, 1893, and established themselves there for the winter, being comfortably settled when the steamer left on August 20. Sledging parties were at once dispatched to *cache* provisions at convenient depots on the inland ice on the way to Independence Bay. Mr. Peary intended to commence his main journey about the middle of March this year, and to reach Independence Bay in the first week of May. Here the party will divide, three men being dispatched to sledge southeastward and survey the coast along the quite unknown stretch to Cape Bismarck, returning thence across the ice cap to Inglefield Gulf. The other party will push northward from Independence Bay, and endeavor to completely survey the land which was seen across the strait last year, at the same time trying to attain the farthest north. The position of Navy Cliff, on the south side of Independence Bay, was fixed as 81° 37′, and since Lockwood's farthest north was 83° 24′, it is practically certain that Peary, with his great experience of foot travel on the ice, will be able to make his way more than the 125 miles which would carry him nearer the pole than any previous traveler. This year he is not to depend entirely on dog sledges, but to experiment with Mexican donkeys, which are accustomed to carry heavy loads in the low temperature and thick snow of the high Cordilleras. Whatever the result may be in record breaking of northern latitudes, we may confidently expect a great deal of solid geographical and scientific work from this expedition. A steamer will call at Bowdoin Bay to bring back the party, or at least obtain news of them, in August or September.

The third expedition left Tromsoe on May 1, 1894, for Spitzbergen, with the object of repeating the attempt so gallantly made by Parry in 1827, when he reached 82° 45′. It is under the command of Mr. Walter Wellman, a journalist, of Washington, who has carefully thought out his plan of action, and has commenced to carry it into effect without delay. Although he has had no previous Arctic experience, he is a man of great energy and enthusiasm; his companions are as enthusiastic and resolute as himself, and it is by no means improbable that he may be able to give a good account of his time. He terms his enterprise "a dash for the pole," and is determined to be back in America before the end of October. However, as a precautionary measure he is to provision the old seal hunters' house on Danes Island in the northwest of Spitzbergen for a year, in case of enforced wintering. The object of starting so early in the season is to avoid the strong southerly drift of the ice, which so greatly hampered Parry's sledging parties. Thus, if Mr. Wellman's theory is correct, he will reach his farthest north before the drift becomes serious, and have the southward drifting ice floes to help him on his return. By the use of very light boats, constructed entirely of aluminum, and provided with runners to convert them into sledges, the weight to be pulled will be greatly reduced. It is to be feared that Mr. Wellman's plan of taking Belgian draught dogs for his sledges will lead to difficulties on account of the difference in climate and in the nature of the work from those to which they are accustomed. The behavior of the aluminum boats will be looked forward to with much interest.

Finally, the Jackson-Harmsworth expedition will take the field early in July, having for its purpose the exploration of the polar area lying north from Franz-Josef Land. Mr. Harmsworth, who is bearing the whole cost of the expedition, has purchased the Windward, of Peterhead, a well known steam whaler of 320 tons, to take the party out to Franz-Josef Land, but the exploration will be conducted by land or across the ice. Mr. F. G Jackson, the originator and leader of the expedition, has long thought over this matter,

NORTH POLAR MAP TO ILLUSTRATE PROJECTED POLAR EXPEDITIONS.

and devoted most of his time for two years to the study of Arctic problems. He spent a great part of last winter in the north of Russia, testing sledges and other appliances for ice travel and practicing surveying on the little known Waigatz Island. Like Peary, he intends to try the endurance of stronger animals than dogs in Arctic work, proposing to take a number of Russian ponies. The *personnel* of the expedition, although probably not exceeding six, will include trained specialists and collectors, who will map their route, make meteorological and magnetic observations, and collect geological, botanical, and zoological specimens. After calling at Archangel, in the end of July, to take on board a Russian log house, and then at Khabarova to ship West Siberian dogs and drivers, the Windward will proceed to Franz Josef Land and make a landing somewhere in the south of that region, the exact spot depending on the state of the ice. The route to Franz-Joseph Land will thus be due north from near Kolgueff Island, instead of northeastward from Norway, as shown on the map. The wooden house will be erected on a secure and sheltered site, and stocked with the necessary stores for four years, after which the ship will return. If, as seems possible from Payer's observations, Austria Sound should be found open, provisions will be carried north along it in a steam launch and *cached* for subsequent use. Mr. Jackson and his companions will spend the winter at their base, where the conditions of life were found to be quite endurable by Mr. Leigh Smith when he was compelled to spend a winter there, with very poor accommodation and equipment, after the wreck of his yacht, the Eira, in 1881. Early in the spring of 1895 the expedition would push northward, moving very slowly because of the necessity of traversing the distance several times over in order to carry the quantity of stores necessary to establish a depot every thirty or forty miles along the route. This slow progress will, of course, give an opportunity for repeating observations for position, and so add to the accuracy of the map. The direction of advance will probably be along Austria Sound and across Petermann Land, the farthest north sighted by Payer in the Austro-Hungarian expedition, and lying in 83° N. Should Petermann Land extend to the north, Mr. Jackson intends to proceed along it, mapping his route as he goes. Boats would be carried for crossing open water, and if oceanic ice intervenes, it would be traversed as rapidly as possible, and a return made to the farthest north point on solid land, where winter quarters could be established; but should this be impracticable, the retreat would be continued to the base, where the second winter would be spent. In the spring of 1896 the party would turn northward again, the chain of depots accelerating their progress. In the summer of 1896 the ship will return with additional stores and men, and to obtain news; but it does not appear to be Mr. Jackson's intention to return, unless he is satisfied that his work is final, until 1897. This expedition ought certainly to extend our knowledge of the most northerly land known, and if fortune favors it, the advances made may be great. Its equipment is of the very best, and no excuse of bad material can be brought forward to explain unsatisfactory results.

The expedition for the exploration of Ellesmere Land to which reference has several times been made in *Nature*, planned by Mr. Robert Stein, of the United States Geological Survey, has been postponed; we hope only until next season. Still, efforts will be made this summer to clear up the fate of the unfortunate young Swedish naturalists, Bjorling and Kalstenius, with their mate Gilbert Dunn, and cook, Herbert MacDonald, of whom the last news received was that they intended to seek shelter with the reported Eskimo of Ellesmere Land. Mr. Elis Nilson has been sent out by the Swedish Anthropological and Geographical Societies, on the Dundee whaler Eclipse, to visit the Carey Islands and Clarence Head, if the ice permits, and search for any relics of the missing party, whose fate, after two years without supplies, can scarcely be considered doubtful. Baron Nordenskjold has interested himself particularly in the search, and will probably arrange for other whalers to deviate from their course in order to obtain information.

Dr. F. A. Cook, the ethnologist on Peary's former expedition, has issued a prospectus of a pleasure trip which he is to conduct up Baffin's Bay to Smith Sound, with the opportunity of a slight change of route should any of the passengers desire it. This would, if the state of the ice permitted, render it possible to call at Clarence Head and the Carey Islands, and make at least a hasty search for the missing party; but a pleasure trip scarcely lends itself to serious Arctic exploration.

Prophecy with regard to the results of geographical exploration is too uncertain to be indulged in by modern critics, and in Arctic exploration particularly the conditions are so difficult to predict that success may attend the most inexperienced and worst equipped, while experience and all the resources of wealth and science would struggle in vain against adverse conditions. There are certain remarkable features about the new expeditions which distinguish them from most of the earlier efforts. Each has been planned and is being carried out by a man who is thoroughly in earnest, and whose reputation rests on his success. This is widely different from the case of a commander "ordered" to carry out the plans of others. Each expedition is small; Nansen's, which is the largest, comprises only thirteen men. Two of those which have already faced the awful monotony of the Arctic night have appliances for dissipating the darkness by the electric light—an advantage which can hardly be overestimated in its effect on the spirits of the men. Provisions and equipments have been greatly improved, even since the time of the Alert and Discovery and of the Jeannette. Most important of all, three of the expeditions are free from the responsibility of a ship. In all these ways the four serious attempts of this year have elements of success never combined previously. Their results will not be known for some time. News of Mr. Peary will certainly be received next autumn by the vessel to be sent up to Inglefield Gulf to bring him home if he considers his work satisfactorily finished. It is probable that Mr. Wellman also will return; but unless he should, by some scarcely credible good fortune, meet the crew of the Fram at his farthest north, we cannot hope to hear of Nansen for another year at least; and Mr. Jackson's scheme provides for a possible absence on his part for four years, though progress should be reported before the end of next year.

HUGH ROBERT MILL.

## THE WELLMAN POLAR EXPEDITION.

THE Polar expedition, under Mr. Walter Wellman, which sailed from Tromso, Norway, on May 2, left Aalesund (which place was made its headquarters) on April 24, in the screw steamer Ragnvald Jarl, a stanch little vessel, specially constructed for whaling and sealing, and reported by Mr. Wellman to be "the best ship for ice navigation to be found in Norway, and next to the Fram (Nansen's ship) the best in existence." The vessel shipped all the stores, the aluminum boats and sledges, the dogs, and most of the members at Aalesund, the others joining her at Tromso. The *London Daily Graphic* gives the following particulars.

The object of the expedition is to attain, if possible, the farthest point north during the course of one season, and its leader deems it possible even to reach the Pole itself, owing to the advance being made from a point at a very high latitude—a latitude at which other explorers have had to turn back—and the extreme lightness of his equipment and stores, which will allow of rapid traveling over the frozen sea. The partly will be conveyed to Danes Island, on the northwest coast of Spitzbergen, where a depot in charge of Mr. Oyen and one man will be established. The other adventurers will push on in the ship to the edge of the Polar ice, there land with their stores, boats, sledges, and dogs, and thence advance northward for twenty-five days, when some of the members will return to the vessel in order to report progress, and steam in her to Tromso about the middle of July. The main body proceed on for another thirty-five days, at the end of which time it will turn back. The Ragnvald Jarl will meet the party early in October, and if all goes well, return with it to Europe. The ship has been chartered for any length of time her services may be required, is provisioned for twelve months, and fitted out for wintering in the north, should it become necessary to do so.

Mr. Walter Wellman, the organizer and leader of the present expedition, now thirty-five years of age, commenced life as a boy in a general store in Nebraska, and at twelve years of age was apprenticed to a printer. At fourteen he began to edit a newspaper. In 1884 he joined the staff of the *Chicago Herald*, and during the last five years has been correspondent and representative of that journal at Washington. Three years ago he undertook the leadership of an expedition sent by the *Chicago Herald* to the West Indies to discover and determine the spot at which Columbus first landed on American soil. He is a handsome, powerfully built man, possessed of untiring energy and determination, and consequently, is admirably fitted to be the leader of such an expedition.

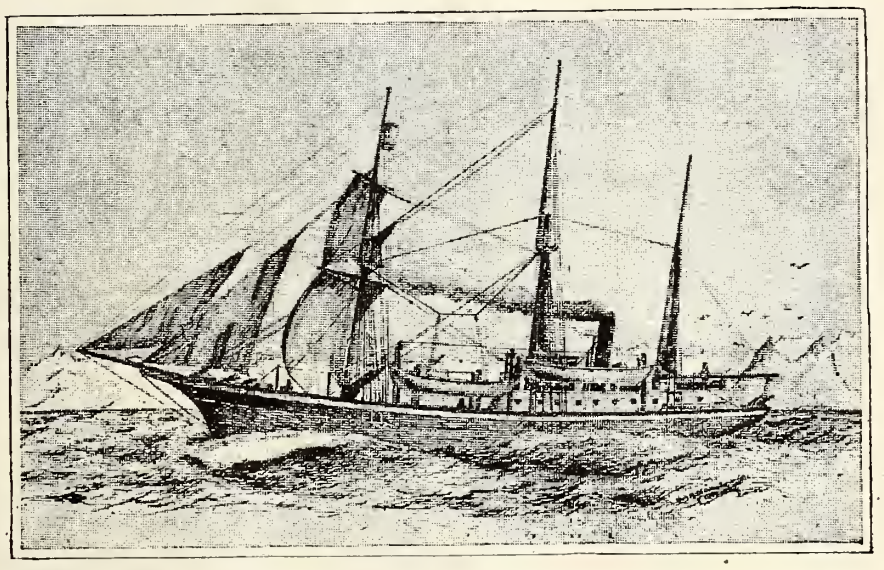
The expedition consists of Professor Owen B. French, aged twenty-eight, astronomer and topographer; Dr. Thomas B. Mohun, aged forty, surgeon and physician; Charles C. Dodge, aged thirty, naval coustructor and photographer; Lionel W. Winship, aged twenty-one, engineer; Alfred S. Franklin (born Samuelsen), interpreter. Mr. Winship is a British subject, who, notwithstanding his youth, has traveled half the world over, and now turns from the glowing heat of Arabian deserts to the chill wastes of the frozen North. Franklin, so called, an American citizen, though Norwegian by birth, is slightly known in professional racing and speed skating circles in the States. Norwegians: Peter Oyen, aged thirty, geologist (will remain at Spitzbergen); Jens T. Dahl, aged twenty-five, mineralogist; Helge Alme, aged thirty, geologist; Fred Juell, aged twenty-four, and Trygve Heyerdahl, aged twenty-three philosophical students; Captain Emil Pedersen, pilot on the Polar pack; and H. Wastfeldt purser. Three men are also engaged for general duties, and the crew of the Ragnvald Jarl is nine men all told.

The outfit is unique in its way, consisting of three aluminum boats, fifteen aluminum and three wooden sledges, tents, Norwegian reindeer sleeping bags, ski and Canadian snow shoes, while the provisions consist of highly concentrated meats and vegetables in tins, but plenty of fresh seal, walrus, and bear's flesh will, no doubt, be obtainable. Winchester repeaters form the principal firearms, but some of the new Norwegian Schou's cylinder magazine rifles have also been taken. The boats are of the Jersey and Long Island type of lifeboat—two of them 18 ft. in length, 4½ ft. beam, and 2 ft. in depth; the other 16 ft. by 4 ft. and 2 ft. in depth. They weigh respectively 400 lb. and 350 lb., are furnished with runners, and thus can be dragged over the ice with ease. Ordinary wooden boats of their size would weigh about four times as much. Each of the boats has cost about £275. The sledges are flat sheets of metal, turned up in front, in shape like a toboggan of the so-called "Hudson Bay" pattern. They weigh 26 lb., and are convertible into boats by means of watertight cases which can be fastened on to them.

The dogs, now fifty-two in number, are Belgian, or rather from Belgium, of all sorts and descriptions and nondescriptions, and though, doubtless, admirable for draught purposes in Central Europe, they will probably prove to be entirely unfitted for Arctic work. The broad-footed dog of warmer climes cannot compete with the fox-footed Eskimo ("Eskimo" includes the Finn and Siberian dogs). Even in Norway foreign sporting dogs get chapped feet on the snow, or have to stop continually and eat the snow and ice from between their toes ere they can walk further, while sores thus created heal with difficulty during frost. Mr. Wellman has, in this respect, been singularly unfortunate in his choice, but, with American foresight, has taken a supply of moccasins wherewith to protect their paws. General experience, however, shows that when a foot is thus encumbered the dog sits down and bites off the shoes; and even should the beasts be trained to wear such coverings, no trial has, as yet, been made of the traction power of a booted dog. European dogs, too, are accustomed to good feeding daily, while the Eskimo can retain their strength for days without sustenance, and live on seal flesh, garbage, or offal, which would be rejected by the civilized animal.

The ship Ragnvald Jarl is a handy, substantial little craft, built for the whaling trade at Aalesund in 1873, a trifle over 98 feet keel, 24 feet beam, and nearly 11 feet depth of hold, 120 net register tons, 186 gross, rigged as a three-mast schooner, with engines of 22 horse power nominal, which at her latest trial gave her a speed of 7 knots. She has taken reserve portions of machinery, screws, etc., in the event of accident. She flies the stars and stripes, and the flag of the expedition, bearing the letters W. N. P. E.

Mr. Wellman has described his venture as a "pioneering expedition" which may pave the way for future scientific exploring parties. He has certainly chosen the best route to the most accessible point of land in the far North, and a dash thence over the Polar ice will very likely enable him, with his comparatively light loads, to attain a higher latitude than Parry did in 1827, provided he proceeds due north, but he must eventually be stopped, as Parry was, by the southward drift of the ice. Wellman's theory that the flow ceases for some eight or nine months of the year, and that in his advance northward he will have the advantage of traveling over motionless ice, has yet to be proved, and were this to be the case, Nansen's plans, which are based entirely on a constant drift, would be entirely upset. Should, however, Wellman find himself mistaken, he says, "We are prepared to take advantage of the circumstances, no matter what they be. If we cannot carry out our plans as originally intended, we can possibly effect our object in some other way." He thus reserves to himself the right to proceed in any direction he sees to be the fittest.



THE WHALER RAGNVALD JARL, CHARTERED FOR THE WELLMAN POLAR EXPEDITION.

## THE BACILLUS ANTHRAX IN CALIFORNIA.

WHILE the Bureau of Animal Industry of the United States claims that California has no anthrax, it is of paramount importance to call their attention and that of the public in general to the fact that Dr. C. L. Bard has seen hundreds of cases in cattle and sheep, and treated many cases in human beings in California. The doctor in his paper states:

"I am prepared to say that the soil of certain sections of our State is polluted by the presence of the bacillus anthracis, and has been for more than twenty years, during which period there have been frequent outbreaks of the disease in animals, so frequent in fact that anthrax may be said to be enzootic in the district comprising the counties of Los Angeles, Orange, San Diego, Kern and Ventura. In my description of the appearance and existence of the disease, I confine myself to the results of my observations in my own country, where I have practiced medicine for more than a quarter of a century. In 1872 a sheep owner, residing near Bakersfield, placed in his band of sheep (five thousand in number) some bucks which had been imported from an infected district of France. Shortly after this acquisition, the animals began to die from

the effects of a disease which to the owner was unknown. Concluding that it might be due to local causes, he started toward the cooler country of the coast. He proceeded to San Fernando, and from there to the plains of Ventura county. In six weeks he lost more than one-half of his flock, and the localities where it grazed are infected to this day. They have been swept by fire, deluged by rain, torn up by the plow, exposed to the heat of southern sun, deserted for years at a time, but the resumption of their use as range has invariably resulted in an outbreak of the disease. One of these ranges, two years afer its infection by Edouart's band, was rented by a sheepman who placed on it a band of eight thousand sheep. Shortly after its occupation the malady appeared, and in two years' time, the owner, who was stubborn, deaf to advice from others, and determined to remain, lost every one of them. On the same ranch a few years later, the majority of a band of cattle, seven hundred in number, succumbed to the same disease. Last November a firm of cattlemen leased an infected ranch, upon which seven hundred and fifty indigenous cattle were at the time grazing. No manifestation of the disease had occurred for years. The importation of one hundred and ninety-five head from an infected locality but fifteen miles away was followed by the appearance of the disease, which virtually carried away every one of them. Nine hundred more were brought in from Arizona, and of these, six hundred perished, the remainder being saved by their removal. The process of infection since its inception has steadily progressed, so that many places in the mentioned counties are for the time unfit for grazing purposes. . . .

"Since the first appearance of the disease there have been at least one hundred cases of malignant pustule in Ventura county. They have corresponded in every particular to the description already given, and, with but one exception, were situated in exposed portions of the body. The majority of them were in the herders who had inoculated themselves while skinning dressed animals. The others were inoculated by fly bites. In this number were two ladies and two children I have never seen a case transmitted from man to man or from man to animal. All of my cases, with the exception of one, resulted in recovery. A microscopical examination of the blood, made six hours after the autopsy (in this fatal case), showed it swarming with the rod-shaped bacilli and their spores. . . .

"The treatment of the disease, as variously recommended, consists of excision, cauterization, deep injections of iodine, carbolic acid, potassic permanganate or corrosive sublimate in solution. Davies-Colley reports the successful use of ipecacuanha locally in form of powder, and internally in five grain doses every four hours. Muskett, who in South Africa treated fifty cases without a death, used it also. The treatment usually followed in California's infected districts has consisted in the hypodermic and local application of carbolic acid. During the last few years, however, I have relied upon deep crucial incisions and the application of a saturate solution of the mercuric bichloride, supplemented by the usual antiseptic dressing. In all cases stimulants, quinine and the tincture of the chloride of iron have been administered internally."—*Proceedings of the California State Sanitary Convention.*

## MEANS OF PROTECTING PLANTS AGAINST BLIGHT AND INSECTS.

THE following so called Spray Calendar, sent out by the Horticultural Division of the Cornell University Agricultural Experiment Station, seems to us so useful that we give it entire, hoping that it may reach the fruit growers among our readers in time to save their crops from some of the dangers which each year is sure to bring.

In the preparation of this calendar the most important points regarding sprays have been selected and arranged in such a manner that the grower can see at a glance what to apply and when to make the applications. The more important insect and fungous enemies are also mentioned, so that a fairly clear understanding of the work can be obtained by examining the table below. When making the applications advised, other enemies than those mentioned are also kept under control, for only the most serious ones could be named in so brief an outline. The directions given have been carefully compiled from the latest results obtained by leading horticulturists and entomologists, and they may be followed with safety.

In this calendar some applications are italicized, and these are the ones which are *most important.* The number of applications given in each case has particular reference to localities in which fungous and insect enemies are most abundant. If your crops are not troubled, when some applications are advised it is unnecessary to make any.

By E. G. LODEMAN, Assistant Horticulturist, Cornell University Experiment Station, Ithaca, N. Y.

### FORMULAS.

*Bordeaux Mixture.*

| | |
|---|---|
| Copper sulphate | 6 pounds |
| Quicklime | 4 pounds |
| Water | 40 gallons |

Dissolve the copper sulphate by putting it in a bag of coarse cloth and hanging this in a vessel holding at least 4 gallons, so that it is just covered by the water. Use an earthen or *wooden vessel.* Slake the lime in an equal amount of water. Then mix the two and add enough water to make 40 gallons. It is then ready for immediate use. For rots, moulds, mildews, and all fungous diseases.

*Ammoniacal Copper Carbonate.*

| | |
|---|---|
| Copper carbonate | 1 ounce |
| Ammonia | enough to dissolve the copper |
| Water | 9 gallons |

The copper carbonate is best dissolved in large bottles, where it will keep indefinitely, and it should be diluted with water as required. For same purpose as Bordeaux.

*Copper Sulphate Solution.*

| | |
|---|---|
| Copper sulphate | 1 pound |
| Water | 15 gallons |

Dissolve the copper sulphate in the water, when it is ready for use. *This should never be applied to foliage, but must be used before the buds break.* For peaches and nectarines use 25 gallons of water. For fungous diseases.

*Paris Green.*

| | |
|---|---|
| Paris green | 1 pound |
| Water | 250 gallons |

If this mixture is to be used upon peach trees, *1*

*For aphides or plant lice use kerosene emulsion on all plants.*

| PLANT. | First Application. | Second Application. | Third Application. | Fourth Application. | Fifth Application. | Sixth Application. |
|---|---|---|---|---|---|---|
| APPLE, (*Scab, codlin moth, bud moth.*) | When buds are swelling, copper sulphate solution. | *Just before blossoms open, Bordeaux. For bud moth, Arsenites when leaf buds open.* | *When blossoms have fallen, Bordeaux and Arseniles.* | *8–12 days later, Bordeaux and Arsenites.* | 10–14 days later, Bordeaux. | 10–14 days later, Bordeaux. |
| BEAN, (*Anthracnose.*) | *When third leaf expands, Bordeaux.* | *10 days later, Bordeaux.* | 14 days later, Bordeaux. | 14 days later, Bordeaux. | | |
| CABBAGE, (*Worms, aphis.*) | *When worms or aphis are first seen, Kerosene emulsion.* | 7–10 days later, if not heading, renew emulsion. | *7–10 days later, if heading, hot water 130° F.* | Repeat third in 10–14 days if necessary. | | |
| CHERRY, (*Rot, aphis, slug.*) | As buds are breaking, Boideaux; when aphis appears, Kerosene emulsion. | When fruit has set, Bordeaux. If slugs appear, dust leaves with air slaked lime. Hellebore. | 10–14 days if rot appears, Bordeaux. | 10–14 days later, Ammoniacal copper carbonate. | | |
| CURRANT, (*Mildew, worms.*) | *At first sign of worms, Arsenites.* | 10 days later, hellebore. *If leaves mildew, Bordeaux.* | If worms persist, Hellebore. | | | |
| GOOSEBERRY, (*Mildew.*) | *When leaves expand, Bordeaux.* | *10–14 days later. Bordeaux.* | *10–14 days later, Ammoniacal copper carbonate.* | *10–14 days laler, repeat third.* | | |
| GRAPE, (*Fungous diseases.*) | In Spring when buds swell, copper sulphate solution. | *When leaves are 1–1½ inches in diameter, Bordeaux.* | *When flowers are open, Bordeaux.* | *10–14 days later, Bordeaux.* | 10–14 days later if any disease appears, Bordeaux. | 10–14 days, Ammoniacal copper carbonate. Make later applications of this if necessary. |
| NURSERY STOCK, (*Fungous diseases.*) | *When first leaves appear, Bordeaux.* | *10–14 days, repeat first.* | 10–14 days repeat first. | 10–14 days repeat first. | 10–14 days repeat first. | 10–14 days, repeat first. |
| PEACH, NECTARINE, (*Rot, mildew.*) | *Before buds swell, copper sulphate solution.* | Before flowers open, Bordeaux. | *When fruit is nearly grown, Bordeaux.* | *5–7 days later, Ammoniacal copper carbonate.* | 5–7 days later repeat fourth. | 5–7 days later repeat fourth if necessary. |
| PEAR, (*Leaf blight, scab, psylla, codlin moth.*) | As buds are swelling, copper sulphate solution. | *Just before blossoms open, Bordeaux. Kerosene emulsion when leaves open, for psylla.* | *After blossoms have fallen, Bordeaux and Arsenites. Kerosene emulsion if necessary.* | *8–12 days later, repeat third.* | 10–14 days later, Bordeaux. | 10–14 days later, Bordeaux if necessary. |
| PLUM, (*Fungous diseases, curculio.*) | When buds are swelling, copper sulphate solution. | *When blossoms have fallen, Bordeaux. Begin to jar trees for curculio.* | *10–14 days later, Bordeaux.* | 10–20 days later, Bordeaux. | 10–20 days later, Ammoniacal copper carbonate. | *2–3 weeks before Plums ripen, Bordeaux, or Ammoniacal copper carbonate.* |
| POTATO, (*Blight, beetles.*) | *When beetles first appear, Arsenites* | *When vines are two-thirds grown, Bordeaux and Arsenites.* | 5–15 day later, Bordeaux. | | | |
| QUINCE, (*Leaf and fruit spot.*) | When blossom buds appear, Bordeaux. | When fruit has set, Bordeaux. | 10–20 days later, Bordeaux. | *10–20 days later, Bordeaux.* | *10–20 days later, Bordeaux.* | |
| RASPBERRY, BLACKBERRY, DEWBERRY, (*Anthracnose.*) | Before buds break, copper sulphate solution. | During summer, if rust appears on leaves. Bordeaux. | (*Orange or red rust is treated best by destroying the plants.*) | | | |
| STRAWBERRY, (*Rust.*) | *As first fruits are setting, Bordeaux.* | As first fruits are ripening, Ammoniacal copper carbonate. | *When last fruits are harvested. Bordeaux.* | Repeat third if foliage rusts. | | |
| TOMATO, (*Rot, blight.*) | At first appearance of blight or rot, Bordeaux. | Repeat first if diseases are not checked. | Repeat first when necessary. | | | |

*Black knots on plums or cherries should be cut out and burned as soon as discovered.*

pound of quicklime should be added. Repeated applications will injure most foliage, unless lime is added. *Paris green and Bordeaux can be applied together with perfect safety.* The action of neither is weakened, and the Paris green loses all caustic properties. For insects which chew.

*London Purple.*

This is used in the same proportion as Paris green, but as it is more caustic it should be applied with the lime or with the Bordeaux mixture. Do not use it on peach or plum trees. For insects which chew.

*Hellebore.*

Fresh white hellebore..... 1 ounce
Water..... 3 gallons

Apply when thoroughly mixed. For insects which chew.

*Kerosene Emulsion.*

Hard soap .....½ pound
Boiling water ..... 1 gallon
Kerosene..... 2 gallons

Dissolve the soap in the water, add the kerosene and churn with a pump for 5 to 10 minutes. Dilute 10 to 15 times before applying. For insects which suck, cabbage worms and all insects which have soft bodies.

I. P. ROBERTS, Director, Ithaca, N. Y.

## AMERICAN SHEEP.

DURING the last few years the sheep industry in Montana and Dakota has grown to enormous proportions, though since the agitation for free wool many men have given up sheep raising. Still, experts place the number of sheep in Montana alone between three and five million head. During the winter the ranchman only attempts to keep his sheep alive, as grass and water both run short and food is difficult to obtain. Two years ago some Montana men sent a flock of 10,000 sheep to Minneapolis to be fattened during the winter on the waste from the flour mills of that city, and the experiment turned out so well that the number sent is now being largely increased. Our illustrations represent the sheep in the Minneapolis stock yards. The sheep are split up into bands, as the ranchmen call them, of about 5,000 in a band, as the sheep are thus more easily managed than if they were all penned together. The ranchmen who look after these flocks are men of great experience and judgment, and have the finest bred sheep dogs obtainable to help them in the management. One thoroughly good dog and its master can look after 23,000 sheep. When the sheep arrive at Minneapolis and the other towns near they are in poor condition, but they rapidly put on flesh, and gain on an average 8 lb. to 10 lb. a month. The sheep are fed on "screenings" or waste flour from covered bins about 6 ft. long and as many high, with a long narrow slit at the bottom into which the "screenings" fall. In the severe weather the yearlings, and also the older sheep, go into sheds which are placed all over the yards, but even when the mercury is at 20 deg. below zero the thick-fleeced animals will munch their hay in the open. The United States consume some 600,000,000 pounds of wool in a year, about half of which is produced in the country, and the number of sheep is placed at 45,000,000. It is feared by the native producers that if wool is placed on the free list the Western States will be beaten out of the field by the cheaper wool from Australia. The reason for this is that the ranchmen pay more attention to the fleece than to the mutton, and so lose much that they might make out of the sale of the carcasses.—*Daily Graphic.*

A Rancher and his Flock.

A Hay-bordered Lane in the Open.

WINTERING SHEEP FROM WESTERN RANCHES IN THE MINNEAPOLIS STOCK YARDS.

## IRRITABILITY OF PLANTS.

AT the last meeting of the Versammlung, or meeting of German naturalists and physicians, Prof. Pfeffer gave an address on the above subject—one which his own work has done so much to elucidate. Irritability, he points out, is not an exceptional characteristic found in special plants; it is a fundamental quality existing in all plants, from the highest to the lowest, although its manifestations in great measure escape superficial observation. The sensitiveness of a mimosa, the curling up of tendrils when touched, or the curvatures of growing internodes in response to light and gravitation, are well known and easily observed instances of irritability. But the less obvious reactions are of equal interest.

Pfeffer instances the remarkable researches of Hegler on the effect of mechanical traction on growth stems, which, when stretched by a weight, gain mechanical strength through the development of the mechanical tissues, which follows as a response to the pull to which they are subjected. Pfeffer has recently shown that resistance put in the way of growing roots increases enormously the energy with which they grow. Other instances of adaptive stimulation escape ordinary observation because of the microscopic character of the reaction. For instance, the extraordinary directive influence of malic acid on the movement of the antherozoids of ferns, or of potash salts on the movement of bacteria. In the same way the irritability of the higher plants is commonly exhibited by movements so slow as to be imperceptible to the naked eye. It is no wonder indeed that the layman does not realize that plants have the same power of reaction to stimulation as animals. Pfeffer remarks, in a striking passage, that "Man would not have inherited such a belief, if the world of plants had been visible to him from childhood as it appears under the higher powers of the microscope. Then he would have had constantly before his eyes the innumerable host of free swimming plants and other low organisms; and the hurrying bacterium turning and rushing toward its food would have been as familiar as the beast of prey springing on its victim. To such eyes the growing stems and roots of the higher plants would have appeared circling with a search-like movement, and many other rapid reactions to stimulus would have been apparent. Under the influence of a multitude of such images, irritability would, without a doubt, have seemed to be a self-evident and universal property of plants."

He goes on to point out how necessary it is to clear our judgments in regard to reactions in which movement is the observed factor. A bacterium rushing across the field of the microscope moves nothing like so fast as a snail, yet it moves rapidly in reference to its own minute dimensions, since it will traverse three to five times its own length in a second, while man at a walk only gets over half his height per second.

The one thing common to all the varied stimulus reactions is that in each of them we recognize a phenomenon of release (Auslosung-), or, to put it in familiar language, a trigger action. Stimulation is therefore release action in living matter.

In classing irritability among trigger effects, we express the fact that the stimulus is only the releasing agent; the nature of the effect depending on the specific qualities of the organism. Just as the touch of a finger may, in the case of human machines, either blow up a powder magazine, start a steam engine, or set a musical box a-playing, so in the case of plants, the same stimulus produces different or even opposite effects on different species.

In machines, as in the living organism, every degree of disproportion between the releasing agent and the amount of energy released occurs. The latent period again is not peculiar to the manner of reaction of organisms, but finds a place in machines of human manufacture. In a clock set in action a period elapses before the striking of the hour (part of released action) comes into play.

It is again no peculiarity of the organism that reaction to stimulus is usually adaptive, since machines are adaptive and self-regulating. The adaptive character of most reactions is as comprehensible as the failure of an organism to adapt itself to conditions not met with in nature. A bacterium being lured to certain death in a mixture of corrosive sublimate and extract of meat is an example of what is meant.

Doubts may arise whether or not certain processes are to be called release actions. Take the case of enzymes. From the point of view of the plant they serve to bring about a wide change at the cost of a relatively small amount of energy. Or take a simpler instance. The tensions which allow the capsule of impatiens to burst or the stamens of parietaria to explode are the product of vital activity, and have, moreover, an adaptive quality. But the release is purely mechanical; there is nothing like *perception* in the ordinary sense of the word, so that these phenomena differ from the reaction of mimosa. Pfeffer, therefore, prefers not to consider the explosions of mimulus, parietaria, etc., as cases of irritability, while he acknowledges that there is no real objection to the word irritability having a wide enough meaning to embrace such cases. All that matters is that we should have a clear conception of the existence and importance of release action in the vegetable organism.

Pfeffer points out that in his "Physiology" (1881) he laid down the same general principles that are developed in the present address, together with examples in various regions of change, and that even earlier, in his "Osmotische Untersuchungen" (1877), he expressed, without reserve, the same views as applicable to the phenomena of life generally. He claims for these views a practical priority in botanical literature, although he fully recognizes that Dutrochet, in 1832, set forth perfectly clear and sound views on the subject.

In 1881, too, he used the word *Reiz, i. e.*, stimulus effect, as equivalent to physiological release action; and he used the expression *Release* intentionally, because of the mystic conception attaching to the terms stimulus and irritability. In fact, he would at the present moment throw over altogether the word *Reiz*, if it were not that the time has gone by for those mystic conceptions of life which are inconsistent with the law of the conservation of energy.

Pfeffer goes on to point out that when, in 1882, Sachs set forth his belief in the general existence of irritability, and in its necessity for the machinery of the organism, he spoke of it not as a phenomenon in the wider category of release actions in general, but as a specific peculiarity of living organisms. Sachs, according to Pfeffer, holds the specific character of irritable organs to be not so much their unstable equilibrium as the fact that after stimulation they return automatically to the labile condition. Pfeffer claims that this definition does not apply to many undoubted cases of stimulation. When callus is produced by injury, or when adventitious roots are developed in response to certain stimuli, there is no such automatic return, but a permanent alteration.

To produce a stimulus reaction, a change in external or in inner conditions is necessary. The sensitive plant does not react to steady pressure, but to variation in pressure.

An analogous state of things is found when a plant in a condition of cold rigor is made to grow by heat. For the change in temperature is merely a stimulus, since it only releases activities which are carried on by the energy at the plant's disposition, not by the heat. At a constant temperature the plant is in a statical condition of irritability, which is a necessary condition for the realization of vital activity.

If the results of temperature changes are not generally recognized by botanists as phenomena of stimulation, this is only a proof of the need of accurate conceptions in this branch of physiology. The association of the word with strikingly visible phenomena is partly to blame for this. Every one recognizes that, for instance, in the opening of the crocus or tulip flower, the change of temperature is a stimulus. In these instances the action of heat may be compared to the regulation of certain machines of human construction by the heat expansion of a metallic rod.

Even when the increased temperature, by increasing molecular action, brings about a union with oxygen, still the temperature change is only the indirect cause of the combustion; and this reasoning applies to respiration.

In a similar sense the addition of a salt of potassium to a culture fluid produces a release action in a plant in which growth was checked by the absence of this element.

Pfeffer has some interesting remarks on the condition of irritability of organs in a condition of equilibrium; for instance, on the continued action of the gravitation stimulus on a geotropic organ growing vertically. Bacteria are less sensitive to the attraction of meat extract when themselves immersed in dilute extract; that is to say, the homogeneous medium, which has no directive action, shows its effect in diminished irritability. The same is true of heat, which stimulates when it varies, and which, when constant, is a necessary condition for certain states of irritability. The idea is not a new one, for no less a man than Johannes Muller (Pfeffer points out) defined the formal conditions of animal and plant life as *Lebensreize* or *integrirende Reize.*

The stimulus need not come from the outside, for just as a clock by internal machinery strikes at intervals so in the organism combinations occur which function as stimuli for certain effects. These are naturally obscure, and for this reason we do well to fix our attention principally on external stimulation: but it can hardly be too much impressed on us that the development and ordered activity of the living body is inconceivable without the co-operation of stimulus from the inside.

With regard to stimulus and reaction, we are in the position of a man, ignorant of mechanics, who sets a machine in motion by a touch of his finger, and who has no idea whether the effect is due to a falling weight, to water power, or to steam. Considerations of this

sort make us realize our ignorance, so that when a new result is observed (in a case of stimulation) we do not even know whether the cause is to be sought in the perception of the stimulus or in the machinery of reply. While denying himself the discussion of cognate points, Pfeffer finds room to call attention to one or two interesting points of resemblance in the irritability of plants and animals.

Thus, for instance, in plants as in man, an increase in the stimulus produces a dulling of sensitiveness. Just as a beggar is stimulated by the gift of a shilling, which on a rich man has no such effect, so a starving bacterium is stimulated to movement by excessively minute quantities of meat extract, while the same organism living in the midst of plenty can only be stimulated to similar movement by an absolutely greater quantity of extract. In the irritability of plants we find, in fact, the relations which are expressed in Weber's law—a proof that the relation in question bas nothing to do with the higher psychic functions.

A plant or a plant organ is never sensitive to a single stimulus only; thus during a geotropic curvature mechanical traction may bring about a strengthening of cell walls, and an injury may produce protoplasmic movement. Here lies a proof that different stimuli do not produce one and the same effect in a given cell, that, in fact, the cell does not react like our eyes, in which the most varied stimuli produce the effect of light. In the case of plants there can be no question of such a limited capacity—of specific energies in the sense of Johannes Muller.

The development of distinct organs of sense whose function is the perception of a single agent is well known to be as little characteristic of plants as of the lower forms of animal life. But distinct organs of sense are no more a condition of irritability than they are of life. Indeed, plants exhibit a variety of sensibilities equal to that of animals, while in delicacy of perception the vegetable kingdom has the advantages. Bacteria are attracted by a billionth or trillionth of a milligramme of meat extract or of oxygen, infinitesimal quantities which we cannot weigh, and of which indeed we cannot form any adequate conception. It is just because the whole secret of life is contained in protoplasm that the simplest organism. such as a bacterium, can be the theater of as rich and varied a play of stiuulus and reaction as the most complicated plant.

## CYPRIPEDIUM MACHROCHILUM GIGANTEUM.

A GRAND addition to our long-tailed cypripediums. This is a hybrid obtained by crossing C. grande with C. caudatum Lindeni. The leaves are 15 to 18 inches long by two broad, stout, and deep green. The scape, carrying several flowers, is about two feet high. The dorsal sepal curls forward in yellowish green, veined with deep green, long and pointed; the ventral sepal is larger and broader, but much paler in color. The petals are green at the base, shading to deep rose and crimson, twisted, and about 15 inches long. The lip is of immense size, white inside, and spotted on the overlapping lobes, with green and deep reddish-brown; tbe inside of the lip is at the base freely spotted with deep rose, the outside is creamy white and green, faced with a suffusion of scarlet on the green. F.C.C., R.H.S., May 8. Messrs. J. Veitch & Sons.—*The Gardeners' Magazine.*

[FROM THE NEW YORK SUN.]

## NEWS ABOUT ANOTHER WORLD.

THE great Lick telescope has just added another to its long list of important discoveries. Prof. Barnard has measured tbe diameters of three of the principal minor planets, or asteroids, Ceres, Pallas, and Vesta, and has found that, contrary to the opinion which has heretofore prevailed, Ceres is the largest of all these little worlds, its diameter being about 600 miles. Previous estimates have made its diameter only 200 or 300 miles. Ceres is now fairly well situated for observation, being a few degrees southeast of the star Delta in the back of the Lion, which crosses the meridian early in the evening. But eveu a telescope of considerable power makes no interesting revelations when turned toward Ceres, for the planet is so small that it appears in the field of view only as a faint star. It is reserved for telescopes of the first magnitude to reveal its round white disk, where no markings indicative of the presence of features resembling those of the earth or the moon have yet been detected. Prof. Barnard remarks that there is nothing in the appearance of Ceres, or its sister asteroids, to suggest the existence of any specially dense or extensive atmospheres surrounding them.

Ceres was the first of the asteroids to be discovered, and it was found on the first day of the nineteenth century. Situated in the midst of the broad gap of space that lies between the orbits of Mars and Jupiter, its mean distance from the sun is about 257,000,000 miles.

There is a theory according to which so small a world as Ceres cannot have an atmosphere, or at least cannot retain one permanently. If we suppose the mean density of Ceres to be the same as that of the earth, tben the force of gravity on its surface is less than one thirteentb of its force on the earth, and any particle moving away from the center of Ceres with a velocity of 2,750 feet in a second would never stop and never go back. But the velocity with which the molecules of oxygen and nitrogen vibrate is believed to exceed 2,750 feet in a second; consequently if Ceres had an atmosphere composed of those gases, the outer molecules at the upper surface of that atmosphere, when their direction of vibration carried them away from the center of the planet, would not cease moving in that direction, and, meeting no obstacle, would pass out into space. In the course of time all of the molecules, upon reaching the surface of the atmosphere, would escape, and Ceres would remain stripped of its airy mantle.

Yet, if we could manage to get to Ceres, and find means of sustaining life upon it, we should perhaps discover how nature deals with such difficulties when she makes a world only 600 miles in diameter. Possibly from another view point than ours Ceres would not seem so absurdly little. It is not much smaller in comparison with the earth than the earth is in comparison with Jupiter. What would people on Jupiter think of such a trifling bit of terraqeous vanity as the earth?

I have assumed, for the sake of an easy calculation, that the mean density of Ceres is the same as that of the earth, but in truth it is probably much less. All of the planets that are further from the sun than the earth is are less dense than our planet. If the whole system was formed from an original widely expanded nebula, the heaviest materials would naturally settle toward the center. We know that the sun weigbs less than the earth, bulk for bulk, but the reason is because the sun is still so hot that all its substance remains in the form of gas and vapor. When it has become solid its density will exceed the earth's. The innermost planet, Mercury, is heavier than a globe of lead of equal size would be, while the outermost planet, Neptune, weighs about as much as an equal globe of water. The progression is by no meaus regular; but there can be little doubt that Ceres, situated so far from the sun, is composed of comparatively light materials. We should not expect to find gold on Ceres. Gold is a heavy weight, and its natural home is Mercury or the sun. It even seems to have had doubts of the propriety of stopping at the earth.

Ceres is the leader of a ring of planets which seem to be absolutely numberless. Hundreds have been discovered; thousands are believed to exist. A few years ago, when astronomers were counting and mapping the stars with telescopic aid alone, they continually stumbled upon new asteroids; now that the heavens are being photographed, dozens of these little worlds previously unknown leave their luminous tracks upon the sensitive plates exposed to the sky at the observatories. The old idea that they are the fragments of a planet which has been blown to pieces was at one time abandoned, but more recently it has been revived in a new form. It has been pointed out that on the supposition of a single explosion it is impossible to account for the present distribution of the asteroids, but that a series of explosions might answer. In that case the original planet, which may have equaled Mars in size, must first have been blown up, and afterward the pieces must have continued to explode one after another, and again and again, perhaps, until they were reduced to their present size. According to this theory, Ceres is simply the largest fragment remaining of an ancient world that may have had an atmosphere and water and other things that pertain to a properly regulated and well furnished planet.

CYPRIPEDIUM MACHROCHILUM GIGANTEUM.

Did it have inhabitants also? If we could go to Ceres, might we pick up among its shattered and blasted rocks some relic that, like the bronze knives of Hissarlik or the ivory carvings of Dordogne, would tell the story of a vanished race?

What a singular fate for a planet—to be blown to fragments! We have been told that ours shall melt with fervent heat, and astronomy knows several ways in which that might be brought about. But for a world to explode and hurl its odds and ends broadcast over the firmament—the modus operandi of that catastrophe remains to be discovered.

The chief difficulty, however, is to account for the first rupture. Comparatively slight explosive energy would be required to blow the fragments themselves to pieces. I have mentioned tbat on Ceres a velocity of 2,750 feet in a second would be sufficient to enable a moving particle to escape from the attraction of the planet. But the vast majority of the asteroids are almost microscopic in comparison even with Ceres. Hundreds are probably only five or ten miles in diameter, thousands are undoubtedly much smaller still. Now, on an asteroid five miles in diameter, supposing again for simplicity's sake that its density equaled the earth's, a velocity of only twenty-three feet in a second would suffice to enable a moving body to escape from the asteroid. The muscular force of a man would be enougb, then, to tear such a planet to pieces and throw its fragments into separate orbits! The motions of the four largest asteroids, including Ceres, are such as may be reconciled with the result of a single explosion modified by the disturbing attraction of the larger planets. It might be supposed then that they, on account of their size, have suffered no second disruption, while the smaller fragments produced by the original explosion have been broken again and again.

Yet the mystery of the first great convulsive dismemberment remains. Yes; but mystery is the soul of discovery.

GARRETT P. SERVISS.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## OPENING OF THE MANCHESTER SHIP CANAL.

ALTHOUGH traffic through the Manchester ship canal has been going on since January 1, 1894, the official opening of the canal did not take place until the 21st of May last, when the Queen in person visited Manchester and, as we might say, pronounced her blessing upon the work. The London *Graphic* says: By the visit of the Queen to the ship canal on Monday, May 21, Manchester was enabled to set the seal of highest honor on the splendid accomplishment of a splendid enterprise. The city made the most of its opportunity, and the Queen was graciously pleased to submit herself to as arduous and as protracted a ceremonial as falls to the most indefatigable of our royal family.

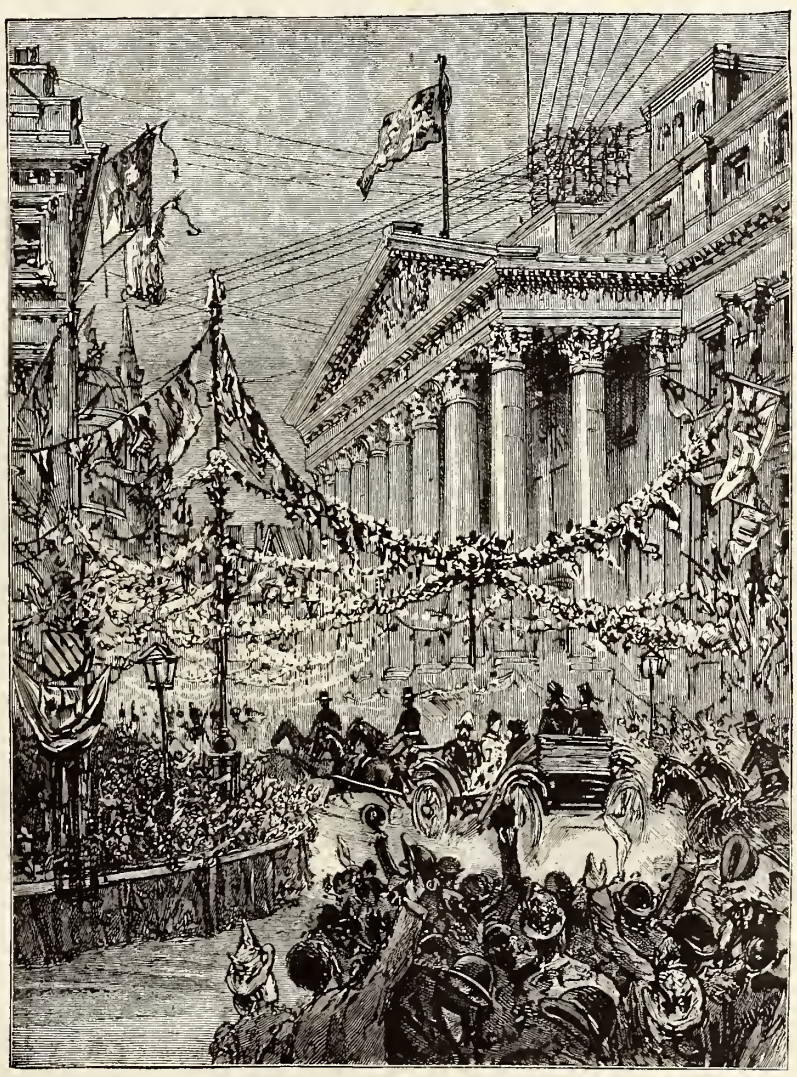
The Queen's interest in the ship canal has always been great—as she said in the admirably chosen words in which she replied to the address presented to her when she embarked upon its waters: "I recognize in this great and important undertaking, and the admirable engineering skill with which it has been constructed, further evidence of the increasing energy and enterprise of my subjects." But even the magnificence of the ship canal might have sunk by comparison with the magnificence of the greeting of the streets. From early morning the excursion trains and the ordinary trains had been pouring into the town the contents of carriages packed, standing, to the windows; and, by the time of the Queen's coming, the principal streets of Manchester and Salford, through which the royal procession was to pass, must have been filled with twice Manchester's population.

When her Majesty emerged from the approach to the London Road Station she looked upon endless lines of upturned faces and upon house fronts where, at every balcony, window and stand, and often upon the housetops, were people waving handkerchiefs in concert with the roar of the crowds below. Flowers stretched across the streets, flowers and pennons ran from mast to mast along the pavement, and scarlet cloth or flaunting flag hung from every window and danced at every corner of masonry. For close upon eight miles and for three hours this was the scene; and these the sounds, varied in degree and detail, but in thoroughness and fine effect constant, which met the Queen's eyes and fell upon her ears.

The journey through the streets and under the triumphal arches of Manchester and Salford, together with the presentation of addresses at various points on the route, may be taken as the first part of the day's ceremonial; the embarkation upon her Majesty's yacht Enchantress at Trafford Wharf, with its attendant presentations, is to be regarded as the second; and the opening of the Mode Wheel Lock as the third, and as symbolically the most important. The addresses which were presented were those of the corporation of Manchester, which was presented at the Town Hall, and which, after referring to the Queen's visit in company with the Prince Consort, neatly introduced the assistance rendered by the municipality to the canal scheme, the welcome of the governing body of Owen's College, which was presented at the Municipal School of Art, the entrance to which had blossomed into roses, lilies and rhododendrons in honor of the occasion; and the address of the borough of Salford, which at the close of its complimentary sentences adroitly observed that the principal locks of this great canal were in the borough.

The Queen's arrival at the gorgeous pavilion which had been erected on Trafford Wharf at the point of embarkation was signaled to the expectant thousands who had been awaiting the Queen's arrival in the mile of scarlet covered stands, and in the gayly dressed steamers along the banks, by running up the royal standard to the button of the flag staff. At the sight the cheers which had run with the Queen's carriage along the lines between which it passed spread far away to distant stands and to distant crowds gathered at convenient points on the sides of the great dock. It should be said, perhaps, for the sake of clearness, that the ships of the canal were mustered at the Salford Docks end; while a long line of pleasure boats successfully hid the inherent griminess of the banks of both sides of the canal, and with their bunting flying from stem to stern gave the correct tone to this novel seaport gala. The gunboats and tenders, whose presence gave color to the observation that Monday was the first appearance of Manchester as a naval port, were moored on the side of the canal opposite to the Enchantress. The Queen only remained for a few moments in the silken pavilion, and then went on board her yacht, where she seated herself on a raised dais in the after-part of the vessel. Accompanying the Queen were Princess Beatrice, Princess Leiningen and Prince Henry of Battenberg. In attendance upon her were Lord Spencer and Lord Carrington. By the Queen's command, the chairman and directors of the company were then presented to her, these gentlemen passing by in review order, and the name of each being announced as he bowed to the Queen. The little ceremony had a distant touch of the drawing room in it.

After the indispensable address, a sentence in the Queen's answer to which we have quoted, had been given and accepted, the lord mayor of Manchester and the mayor of Salford were summoned, bidden to kneel, tapped on the shoulder with the royal sword, and commanded to rise as Sir Anthony Marshall and Sir William Bailey. The public bestowal of this honor had been entirely unexpected, and the crowds in the stands catching sight of the graceful ceremony and suddenly grasping its meaning, began to cheer anew. The Queen was pleased to speak of her gratification at the sight of the great crowds and the abundant decorations, and the newly made knights kissed hands upon retiring.



OPENING OF THE MANCHESTER SHIP CANAL—ARRIVAL OF THE QUEEN AT MANCHESTER

The great event of the day was now approaching nearly. The Enchantress, which had been practicing *her* part in the ceremony for several hours on the previous day, sidled away from the pier, and, with a speeding cheer from the assemblage, steamed slowly upon the waters of the canal toward the Mode Wheel Locks. At the same moment the zealous artillery situated upon the race course at the back of the docks began to fire the royal salute—which, as a matter of fact, had been destined to follow the actual opening of the locks by the Queen. However, the accident did not materially affect the appearance or the prospects of the ceremony, and, in a very few minutes, the Enchantress had reached the locks, had swung round in the most elegant and ladylike way, and was safely moored to the capstans of the piers on either side of the lock gates. A boat put out from one of the piers, took a coil of wire from the Queen's yacht, and sped swiftly back again to the quay. There were a few minutes devoted to rapid adjustment, and then the Queen pressed the ivory button of the mechanical arrangement which stood beside her on the deck. An electric bell trilled somewhere on the quay, there was a movement of suspense while the horrid thought flashed for a moment into the mind that something might have gone wrong after all, and then the huge dock gates opened gently, opened (to quote an eloquent spectator) as softly as a lady's fan. The Queen said "I now declare the canal open." A rocket shot upward as she spoke the words, the band burst jubilantly into the national anthem, and the ship canal was open to the commerce of the world.

## THE MANCHESTER SHIP CANAL.

FOR many years Manchester has lain at the feet of Liverpool. This fact has long been recognized, for over fifty years ago we find Liverpool boasting that she paid more window taxes than Manchester; and, as a writer of that day has said, "nothing could better prove the actual state of affairs, for it shows Manchester to be our great workshop, and Liverpool the residence of the non-producers who live upon its industry." Two hundred years ago Liverpool was a fishing village, but with the growth of the cotton industry in South Lancashire came the need of a point of import for raw material and of export for the manufactured goods.

So rapidly, indeed, has Liverpool risen, that whereas in 1801 her year's tonnage was 459,720 and her dues received £28,365, in 1881 they had risen by steady growth to 7,893,950 tons and £966,280 respectively. But these same dues, admittedly overheavy, added to the exorbitant railway rates between port and mill, were a deadly tax on the Lancashire manufacturer, and a time came at last when the keen competition of foreign rivals compelled him to ease himself of the burden.

The ship canal as now constructed is the realization of an idea over one hundred and eighty years old; an idea frequently recurring from time to time and ever growing in importance and ambition.

Passing over many schemes, more or less feasible, for improving the water communication between the estuary and city, we come at last to the year 1877 and the inception of the present scheme. The idea then first discussed was the construction of a tidal channel right up to Manchester, and this scheme, prepared by the late Mr. Hamilton Fulton, C.E., of Westminster, found much favor in many quarters. And there is something peculiarly attractive in the idea of "the briny" actually flowing under the very walls of the cotton mills. However, when, in 1882, the scheme was seriously faced under the leadership of the late Mr. Daniel Adamson, with a view to the immediate construction of the long discussed waterway, two schemes were submitted to the promoters—the one, as we have just said, by Mr. Fulton, for a tidal channel, the other by Mr. E. Leader Williams, C.E., of Manchester, for a channel tidal up to Warrington, and thence rising step by step, by means of locks, up to the old river level at Manchester. It was then realized for the first time that the tidal scheme would involve a cutting over 90 ft. deep at the Manchester end, and that the quays themselves would be over 50 ft. below street level. In addition to this, there were serious doubts as to the satisfactory working of the tidal flow along a confined channel of such great length.

At the preliminary meeting of supporters, held in September, 1882, it was, therefore, decided to adopt Mr. Williams' scheme for a canalized channel. At the same meeting it was also resolved that a fund of £100,000 should be raised to defray the expenses of an application to Parliament for powers to carry out the scheme.

Then followed the most protracted struggle ever known in the history of private bill legislation. Practically it lasted for ten years, the first three years being spent on the passing of the first bill. The most formidable opponents of the bill were the Mersey Docks and Harbor Board, the Mersey and Irwell Navigation Company, Bridgewater Canal Company, city of Liverpool, London and Northwestern Railway Company, and other strong vested interests. It is probable that this persistent opposition has cost the promoters nearly a quarter of a million, but, at the same time, it is quite certain that the scheme just completed is in many ways much more satisfactory than that first laid before Parliament. The bill received royal ascent in August, 1885. The proceedings in all had extended over one hundred and seventy-five days, and over one hundred and seventy-five thousand questions had been asked and answered. After the passing of the bill came the hard struggle to raise the necessary funds for construction. The capital required was about £8,000,000, with an additional £2,000,000 for the compulsory purchase of existing canals and navigation rights. First a London syndicate and afterward the Rothschilds, of London, attempted to float the company, but in vain. But it was not until 1887, on the reconstruction of the board, with Lord Egerton, of Tatton, as chairman, that further powers as to share

capital were obtained, and, through the agency of Messrs. Baring & Co., the capital required by the act of 1885 was subscribed.

No time was now lost before breaking ground. Mr. T. A. Walker, whose name will ever be associated with the successful construction of the Severn tunnel and other heavy engineering works at home and abroad, undertook to construct the entire waterway within four years for the sum of £5,750,000. Lord Egerton, of Tatton, the chairman, cut the first turf at Eastham on November 11, 1887, and work was begun on the various sections before the end of the year. It is difficult to convey to the lay mind the magnitude of the task undertaken, the amount of excavation alone being simply enormous. Imagine a mound of earth 3 ft. broad and 4 ft. high, formed round the globe along the line of the equator, and some slight idea will be gathered of the quantity of rock, sand, clay, and earth which has had to be removed. To accomplish this, an army of men and boys was employed, and, at the busiest time, these amounted to between 15,000 and 16,000. Even such a mighty host would have been of comparatively little avail if steam plant had not also been largely employed. As a matter of fact, the amount of plant employed has never been equaled on any other engineering work. No less than 215 miles of full gauge railway track was laid in the cuttings and along the banks and tips. The rolling stock of this extensive little railway system amounted to 180 locomotives and over 6,000 trucks. The bulk of the digging was accomplished by ninety-seven steam diggers of various makes, aided by a fleet of half a dozen powerful steam dredgers. Heavy as was the work of rough excavation, it was but a portion of the task faced by the contractors. Five main lines of railway had to be diverted, and lofty embankments leading to new high level viaducts had to be formed for them. Roads innumerable were severed, and provision had to be made for the traffic by the construction of seven immense swing bridges and two high level fixed structures. On the estuary portion of the work several miles of embankment had to be formed to separate the canal from the river in order to maintain full depth of water in the canal at low tide.

As the canal has a fall of over 60 ft. between Manchester and the sea, it was necessary to break up the total length into a series of level ponds, divided by locks having a lift varying from 13 ft. to 16 ft. There are in all five sets of these locks, each of massive construction and immense size, situated respectively at Eastham, Latchford, Irlam, Barton, and Mode Wheel. Those at Eastham are three in number, the sizes being 600 ft. by 80 ft., 350 ft. by 50 ft., and 150 ft. by 30 ft., but they only come into use between half tide and low water; the gates standing wide open during the period of high water, so that vessels may pass in or out without any obstruction. The distance between Eastham and the next locks at Latchford is twenty-one miles, and throughout the whole of this length the water in the channel is semi-tidal.

At Latchford and at the other points mentioned there are only two locks, the one 600 ft. long by 65 ft. wide, and the other measuring 350 ft. by 45 ft. In order to minimize the waste of water when in use, each chamber has been provided with a pair of intermediate gates to suit vessels of different lengths.

The valley of the Mersey has always been liable to sudden and serious floods, and provision had to be made by the engineers for the rapid discharge of large volumes of flood water coming down from the uplands. For this purpose large steel sluice gates of improved design have been constructed alongside each of the lock systems. These sluices can be raised bodily from the bridge above, and, by lifting them as occasion requires, the depth of water in the pond above can be regulated to a nicety. The five sluices at Irlam, for instance, are capable of passing over 200,000 gallons per second, a body of water far surpassing any Mersey flood on record.

Between Latchford and Eastham there are two long weirs in the embankments to permit the free flow of the tide into and out of the canal, and there are also three sets of storm water sluices, at Norton and Eastham, with two gates each, and at the mouth of the river Weaver. At the latter point there is a series of ten great sluices, and when these are all lifted to the full height, an opening 300 ft. in length and 13 ft. high is formed in the retaining wall, so that no fear need be entertained of a flood on the lower reaches of the canal or the river Weaver.

In addition to the main locks already mentioned there are six side locks of smaller dimensions, to connect the new waterway with existing systems of navigation. These are the Weston Marsh, Weston Mersey, Bridgewater, and Old Quay locks, all in the neighborhood of Runcorn, and two near Warrington, at Walton and at Stockton Heath respectively. By far the most impressive piece of work on the whole line of canal is the new swing aqueduct at Barton. The Bridgewater Canal crossed the Irwell at this point, and as the line of the new canal here follows the old course of the river, it is obvious that some means had to be devised by which sea-going vessels could pass this point without severing the barge traffic on the older navigation connecting Manchester with the South Lancashire coal fields.

The difficulty has been solved by the bold device of carrying the barge canal across the new waterway in a steel trough, which can be turned on its center just as an ordinary road swing bridge. Before turning, however, stop gates at the two shore ends of the canal cutting and at each end of the trough are closed, so that when the aqueduct is swung there is no waste of water. The total weight of the moving portion, which always remains full of water, is over 1,600 tons, and the sight of the immense structure—with perhaps one or two barges floating in it—gently revolving on its pivot is most impressive.

The greater portion of the docks is situated in the borough of Salford, the remainder being partly in the city of Manchester and partly in the township of Stretford. The total area of the water space in the docks is 105 acres, while the quay space amounts to 152 acres, with a water frontage of over five miles. The upper end of the Manchester Dock is within a mile of the Town Hall. The Manchester and Salford Docks are divided from each other by the Trafford Road Swing Bridge, which connects the city with the borough.

In addition to the docks at the terminus, a side dock of 23 acres is being constructed at Warrington. At Partington, a coaling basin of 5½ acres has been formed, connected by rail with the South Lancashire and Yorkshire collieries. Partington thus becomes by many miles the nearest port to these pits, and the export trade in "black diamonds" promises to be no mean item in the future traffic of the canal.

For two years after the commencement of the work all went well; but the death of the contractor, Mr. T. A. Walker, in November, 1889, involved the company in a series of disputes with his executors, who had endeavored to carry on the work, as provided by the terms of his will. For twelve months the work was continued with considerable friction, and in the autumn of 1890 all existing contracts were canceled, and the work, with all plant on the ground, was taken over by the company, who continued the task for some months as their own contractors.

About the same time a tremendous flood burst over the whole valley, and almost every cutting between Warrington and Manchester was drowned out. The loss to the company caused by delay and expense of pumping out the cuttings, repair of plant, and making good the damage done, was enormous. This and the severe winters of 1890 and 1891 are largely responsible for the great ultimate increase of the cost of the canal over the Parliamentary estimates. Early in 1891 the company found themselves at the end of their resources, and being unable to raise any further capital, they appealed to the Manchester City Council for help. The corporation at once responded by obtaining the sanction of Parliament to their advancing any sum up to £3,000,000 on the security of the city rates. It proved ultimately that even this vast sum was not sufficient to complete the work, and Manchester has raised another £2,000,000 for the same object. The city thus becomes the largest shareholder in the concern, and has a majority of members on the board of directors until the loans shall have been fully repaid or the canal converted into a public trust.

On November 25, 1893, the fourth anniversary of Mr. Walker's death, the canal was at length full of water from end to end, and on December 7 the Liverpool ferry steamer Snowdrop, with the corporation and directors on board, passed along the whole length of the canal from Eastham to Manchester, being the first vessel to arrive in the new port. On January 1, 1894, the canal was opened for traffic. There was no actual ceremony, but a procession of crafts of all descriptions passed up the canal in the wake of the lord mayor, the corporations of Manchester, Salford, and Warrington, and the directors of the Canal Company.

Numerous lines of steamers are already running to and from all parts, and we notice from the Board of Trade returns just issued that more sugar has been landed this year at Manchester than at Liverpool. In itself this seems a trivial matter, but as the proverbial straw shows the direction of the wind, so this small item is but the indication of the vast shipping industry which Manchester most firmly believes will be hers in the near future.

### A VOYAGE UP THE CANAL.

For some weeks past the well-known Clyde tourist steamer Ivanhoe has been making daily trips along the canal between Manchester and Liverpool. Seeing that she is "billed" to return shortly to her native waters, and again delight the heart of the canny Scot, we propose in imagination to avail ourselves of the present opportunity, and to steam up the new channel, noting the various works of interest constructed in connection with the canal, and the consequent changes which have been made in the district.

Leaving the Prince's Landing Stage at Liverpool at about high water, we rapidly overhaul the tender Skirmisher, having on board the last of the saloon passengers and the late mails for the Cunarder Campania, outward bound; and in a few minutes we pass that leviathan herself at her moorings in the Sloyne. The Blue Peter flutters from her masthead, and the volumes of smoke and steam pouring from her gigantic smokestacks indicate that steam is already fully up for a record run across the Atlantic. Shortly afterward we are abreast of the old line-of-battle ship Conway, now used as a training ship for cadets; and, passing the floating powder hulks moored off Bromborough, we steer toward the southern bank of the estuary, here almost three miles across, and see before us the entrance locks to the canal at Eastham.

The tide having not yet fallen more than a few feet, the entrance gates are still open, so we steam right through the lock chamber, and are at once in the "Port and Harbor of Manchester." Had we arrived at low water we should still have had ample draught in the approach channel, but should have found the lock gates closed. This would have caused a slight delay, while we were being raised to the canal level; but so perfect are the hydraulic contrivances for closing and opening the gates that less than ten minutes would have been lost in the lock. In passing through the lock we notice on our right the twin sluices for regulating the discharge of storm water from the canal, and on the bank beyond we see a fine engine house and accumulator tower for working the hydraulic machinery and for lighting the locks at night by electricity. These last features we shall find at each of the locks on our voyage up stream, the sluices being always on our right, but in every other case the engine house stands on our left hand. For half a mile we pass through a sandstone cutting, and, emerging from this, cross Pool Hall Bay, the waters of the canal and estuary being separated by a great sandstone and clay embankment about a mile long.

Another deep cutting next leads us to Ellesmere Port Bay, across which the canal is again carried by means of a heavy embankment. Ellesmere Port is the terminus of the Shropshire Union Canal system, which connects the Potteries and the "Black Country" with the Mersey, and which now forms a valuable feeder to the Ship Canal. Extensive new quays have been built here in anticipation of increased traffic; and the Ship Canal Dry Dock and Pontoon Company have selected Ellesmere as the site for one of their huge floating pontoon dry docks.

A long spin between the marshy meadows of the Cheshire shore brings us to the mouth of the river Weaver, the only point of special interest passed on the way being the siphon which carries the river Gowy under the canal in two pipes, each of 12 ft. diameter. This work is, of course, invisible from the deck of our steamer. At the mouth of the Weaver stands Saltport, founded in the summer of 1892 for the salt and timber trade on the canal; the impounded waters of the Weaver forming a large pond for the storage of the timber rafts. From this point the canal is carried round the existing docks and outside the twin ports of Western Point and Runcorn, by means of an immense embankment and concrete wall about four miles long. Opposite the mouth of the Weaver this embankment has been cut down to form a tidal weir, as already explained; and at the same point are the ten great storm water sluices to which reference has been made in our history of construction. The Weston Mersey, the Bridgewater, and the Runcorn Old Quay side locks are all formed in this embankment, to allow vessels to pass direct from the old docks into the estuary, instead of navigating the new waterway.

But before reaching the Old Quay lock, we pass under the first bridge spanning the canal. This is the fine viaduct carrying the London and Liverpool branch of the London and Northwestern Railway across the Mersey at Runcorn gap. It existed long before the canal was commenced, but was sufficiently high above high water mark to clear the masts of vessels. The actual headway varies, of course, with the tide, but it is never less than 75 ft. The three main spans are each 100 yards in the clear; so that the Ship Canal, with its bottom width of 120 ft., occupies only half of the Cheshire or southern span. To the north, across the river, lies Widnes, the center of the alkali industry, overhung by its never-lifting pall of inky smoke and nauseating fumes. A few hundred yards up stream of the viaduct the canal strikes inland, leaving the estuary on the left.

Immediately afterward we find the canal temporarily blocked by the first swing road bridge. A deep hoot from our fog whistle warns the operator of our approach; and the bridge swings silently round on its hydraulic pivot, and as gently returns after we have passed. On our way to Manchester we shall have to pass through six more of these swing bridges, which connect the main roads severed by the canal. They vary considerably in weight; the Trafford Road Bridge, between the Manchester and Salford Docks, being the heaviest in the United Kingdom. The weight on its turntable is 1,800 tons. Yet so truly is each of these immense structures poised on its circle of gun metal rollers that they can each be turned in less than ten seconds. Leaving Runcorn behind, we enter the deepest cutting on the whole line of work, and presently find ourselves passing the Norton sluices, where storm waters are discharged into the river above Widnes.

Moore Lane Swing Bridge next comes into view, with its engine house and accumulator tower, but the former needs no tall chimney, as the fuel consumed at this point is oil, instead of coal. Another half mile brings us to Acton Grange Viaduct, an immense structure carrying four railway tracks—the main line of the London and Northwestern Railway Company and the Warrington and Chester branch of the Northwestern and Great Western joint lines. These railways have been raised by means of inclined approaches of easy gradients, so as to give the same clear headway above water as at Runcorn, which has been taken as the standard of height for all the new fixed bridges spanning the canal. We are now passing Warrington on our left, and as we steam through the Stag Inn Swing Bridge, we notice that the Chester Road, which it carries, also crosses the river a few paces away by means of a new girder bridge of an American type. The entrance to the Warrington dock, which has yet to be made, lies about half way between Stag Inn and Stockton Heath Swing Bridges. The river here has been diverted from its old channel round the Arpley meadows, and it is intended by dredging and widening the old bed to form a dock twenty-three acres in extent. Stockton Heath Church stands on the right, just below the fourth swing bridge, and it is so near to the edge of the water that it is possible to throw a stone from the church step on to the deck of a passing steamer. The swing bridge just mentioned has been constructed at the very point of junction of an old barge navigation with the ship canal, and the connecting lock actually stands under the shorter arm of the bridge when at rest.

Another mile of straight cutting brings us to a high level bridge of an entirely different type from any yet passed. This bridge carries the approach road to the new Latchford Railway station. A hint has been borrowed from the great Forth Bridge, and the cantilever principle, of which so much was heard a few years ago, was adopted. Passing now through the Knutsford Road Swing Bridge, and underneath the great skew bridge carring the Warrington and Stockport branch of the London and Northwestern Railway, similar in design to its sister bridge at Acton Grange, we leave at last the tidal waters of the canal, and enter the lock at Latchford. The 600 ft. lock is occupied by the Merchant Prince, outward bound for the Mediterranean with a full cargo of Manchester goods. So we are raised in the 450 ft. chamber. After a delay of a few minutes, we are again under way, and having just been raised 16 ft. in the lock, obtain a much better view of the surrounding country from the Ivanhoe's promenade deck than was possible on the lower reach. About two miles above Latchford we notice two or three huge dredgers at work in the channel, and shortly afterward meet the Manx Fairy, formerly an Isle of Man boat, but now one of the fleet of pleasure steamers owned by the Ship Canal Passenger Steam Ship Company. Leaving the mouth of the river Bollin on our right, the canal bends sharply to the left, and, spanning the deep sandstone cutting, we see ahead the Warburton High Level Road Bridge, similar in every detail to the one at Latchford. At Partington we find a fine viaduct carrying the Midland line from London to Liverpool across the canal and river, at this point very close together. Just above the bridge the canal is widened out to form the Partington Coaling Basin, with laybys on each side of the channel, and we notice that Messrs. Lamport & Holt's fine steamer Oblers lies under one of the tipping cradles taking in her bunker coal before proceeding to Manchester to load for the Brazils. Nearly a mile further up the canal receives the whole flow of the Mersey water coming down from the Derbyshire hills beyond Stockport. The canal itself from this point up to Manchester follows the valley of the river Irwell, and has practically obliterated that tortuous stream.

The Cheshire Lines Viaduct at Irlam is the counterpart of the one at Partington, and can carry four trains abreast, though only two lines are at present laid. Immediately above the bridge, lie the Irlam Locks. Here we rise another sixteen feet, and after steaming two miles through Lancashire lowland flats, enter the Barton Locks. Here, again, we have another rise in the world, this time one of fifteen feet, in less than as many minutes. All eyes are now strained forward to catch the first glimpse of Mr. Leader Williams' masterpiece—the swing aqueduct at Barton. The concrete island which carries the pivot bears also that of the Barton Road Bridge; and as these two huge structures revolve simultaneously on their axis to give us passage, we hardly refrain from bursting into cheers for the designer of these marvels of engineering skill. From Barton to the docks the canal is cut through the precincts of Trafford Park, the ancestral home of the De Trafford family. Before entering the docks, however, another and final rise of thirteen feet is accomplished in the Mode Wheel Locks. Emerging from these, we find ourselves navigating an immense basin,

THE MANCHESTER SHIP CANAL—ROCK CUTTING, MOUNT MANISTY.

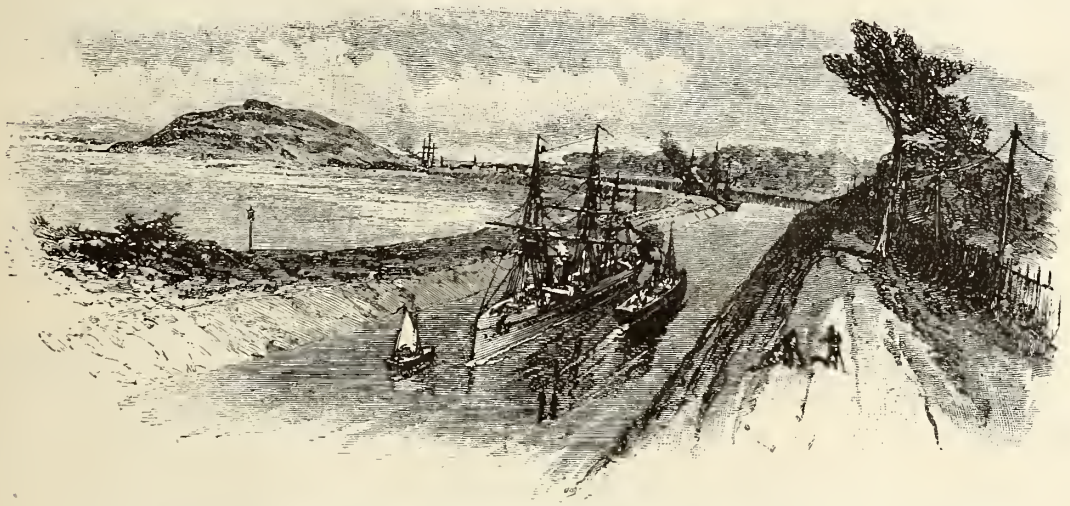
a mile in length and a quarter of a mile across in the widest part. This is the great Salford Dock, and as we steam gently up to our moorings alongside the Trafford Wharf, we notice that the docks are being fitted up with all the most modern appliances. Electric light has been laid on throughout the whole of their extent; telephone wires run round all the basins, and connect them with the dock offices; hydraulic cranes are being erected as fast as the makers can supply them; while, most important of all, railway lines run along the edge of every quay and jetty, so that goods can be loaded direct to ship, to rail, or *vice versa*, without twice handling, as has to be done at Liverpool.

The Ivanhoe does not pass on to the Manchester Docks, but, like all the other passenger boats on the canal, berths at Trafford Wharf in the Salford Basin. We must therefore leave her here, and take our seats on one of the small steamers plying between the wharf and Albert Bridge in the city. Darting rapidly under Trafford Road Swing Bridge, which we clear without the necessity of its opening, we come to the temporary swing bridge connecting the dock's railways with the Midland and other railway systems. This will shortly be replaced by a permanent structure now in course of erection. The four basins of the Manchester Docks open out on our right. On the opposite bank of the canal, which is here the river Irwell widened and deepened, the construction of the Ordsall Dock is being pushed forward as rapidily as possible. At Woden Street Footbridge we come to the head of the docks, but, continuing our course up the river, we touch at the Regent Road stage, and thence steam to Albert Bridge, within five minutes' walk of the Royal Exchange and the Town Hall.

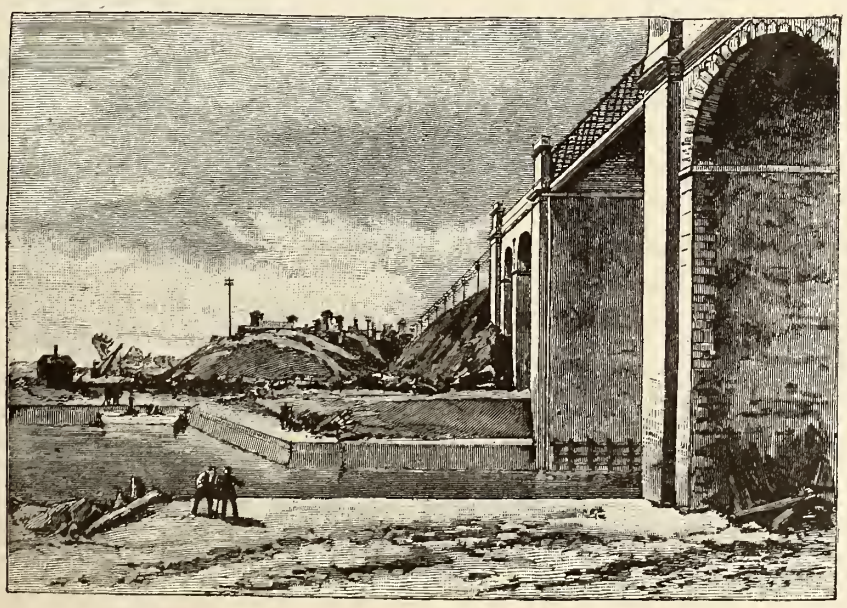
Having thus covered the whole length of the work, it may be said of us as of a certain queen of old, that "there is no more spirit in us," for truly we have nothing but admiration and praise for the men who have conceived and carried out so vast a work in so short a time; and we can but wish the shareholders and the citizens of Manchester all the success that their boldness and patience merit.

We are indebted to the *Illustrated London News* for our illustrations and the foregoing descriptions of the great work.

Maps and numerous other illustrated details of the canal have been given in previous numbers of our SUPPLEMENT.



MOUNT MANISTY, FORMED OF THE EARTH THROWN OUT IN MAKING THE MANCHESTER CANAL.



THE VIADUCT OF THE MIDLAND LINE.

## A GREAT MINING TUNNEL.

THE ingenuity of Americans has been exercised in the past few years in devising economical ways of operating gold and silver mines. One of the most popular schemes to reduce expenses is a tunnel. Individual mine operators have constructed tunnels of more or less depth, but it has been only in recent years that the transportation tunnel proposition has become popular. During the last days of the silver boom, the number of such enterprises that were suggested or started was legion, but only a few ever became possibilities. Among these is the Revenue tunnel, near Ouray, Col., constructed by the Carolina Company, which owns the Virginius mine on Mont Sneffles.

The mine is one of the highest silver properties in the State. The original workings were 12,500 feet above sea level and over 1,000 feet above timber line. During its best years 350 men were employed in and about the mine, and a post office for their convenience was established in the settlement of the mining cabins perched on the steep mountain side. During the winter season the miners were separated from the world for several months, though occasional trips on snowshoes in favorable weather were made down to the mountain-walled, unique town of Ouray, seven miles below.

When the present owners purchased the Virginius, the privilege of working the mine from the adjoining property was denied them, so that from the outset they had to expend money in developing their property. For thirteen years they prosecuted the work. The Virginius mine has been worked through a crosscut tunnel which burrowed into the mountain a distance of 400 feet. At that point a shaft was sunk upon the vein. The top of the shaft is 300 feet vertically underground, and it is 1,400 feet in depth. In the crosscut, 100 feet in from the entrance, a large room was hewn out of the solid rock to contain the battery of boilers, of which there are three, each of 60 horse power. To get this heavy machinery up from the railroad a wagon road had to be constructed to the entrance. The smoke stack rises through solid rock upward of 300 feet to the surface, where it projects a few feet into space. Electricity has been called into use to facilitate the enterprise. Four and one-half miles away up Canon Creek, Pelton water wheels working under a 525 foot headway operate the dynamos that generate the electricity which is wired down to the mine. The current operates electric pumps with a capacity of 200 gallons of water per minute, besides furnishing light to all portions of the property. The hoists are also worked by means of the electric current.

The mouth of the Revenue tunnel is at an altitude of 10,600 feet, and is three miles by trail below the original entrance to the mine. The first work was done by hand until a distance of 250 feet was reached, when steam drills were put in. When a depth of 600 feet was gained air drills were introduced. The rock proved to be the toughest kind of conglomerate. The drills worked under 120 pounds pressure. So hard was the rock that twenty-four inches of steel was often worn off in twenty-four hours' work with the drills. At a depth of 7,741 feet the tunnel struck the vein at a distance of 2,040 feet vertically below the surface. Where the tunnel intersects the vein an incline has been raised at an angle of 55° for a distance of 840 feet to connect with the upper workings. A double hoist is to be placed in this incline, while a runway for the water and waste and a compartment for ladders and wires are provided. The need of pumping will then be at an end, as the water will pass out by gravity through the tunnel.

Another similar enterprise is the Newhouse tunnel, now being driven into the mountains at Idaho Springs. Three years ago Samuel Newhouse, of Denver, who had been engaged about mining camps for fifteen years, and was the pioneer transportation man in the Leadville rush, conceived the idea of constructing a tunnel to tap at a great depth the veins of gold in Gilpin County. His idea was to construct a subterranean railroad with the gold ores of Gilpin County as the freight to be transported. The tunnel is now a thousand feet long. The great rounded hill known as Seaton Mountain, where Russell Gulch has its source, and where the mining camp of Nevadaville clusters, is the territory to be reached by this underground railway. Within this massive granite mountain there are over 300 known veins of gold-bearing mineral. The cost of operating the mines is considerable, for water has to be overcome by means of expensive pumps, coal must be carted to the mines, shafts sunk, machinery purchased and renewed as greater depth is attained, and the ore transported from the shaft to the mills situated down in the valley. The California mine, now at a depth of nearly 2,200 feet, is operated through a single shaft just large enough to permit a cylindrical bucket to be lowered, and through this small opening the miners must go and the water be taken out before the precious mineral can be brought to the surface.

It is under this territory that the Newhouse tunnel is to be driven with the purpose of crossing these veins. The total length of the tunnel as projected is 20,000 feet, and it will cross the California mine vein at a depth of 2,000 feet from the surface. By this tunnel a complete drainage scheme is assured to all the mines, the cost of transportation of ores will be reduced to a minimum, and, instead of expensive machinery to hoist the waste and the mineral, gravity mining can be carried on. The mouth of the tunnel is at Idaho Springs. The breast of the tunnel is 12×12 feet, rising at a regular grade of 6 inches to 100 feet. Its course is a true tangent. The tunnel will have a double track laid with 30 pound rails, with drainage canals alongside, and the transportation of materials in and of ores out will be done by electricity. The tunnel will be lighted by electricity.

Aspen, a distinctly silver camp, has two big tunnel enterprises, one of which, the Cowenhoven, is now being operated. This tunnel was completed last spring, and is now ready to handle the ores of several mines upon a transportation tariff basis, but no contracts will be made by the proprietors pending the long deferred restoration of the silver market. The other enterprise was stopped in its progress last summer. It was planned to reach the ores of another mountain in the Aspen district.

In Leadville several underground tunnels have been constructed in the past to save expense in operating

some of the deep mines, but no public highway underground was attempted until last spring. Now the Silver Cord tunnel is to be driven under Breece Hill to tap the newly developed gold deposits. Another enterprise, which is still almost visionary, is a gigantic drainage tunnel to be run from the Arkansas River under the hills for several miles to reach the entire Leadville district at a low depth and thoroughly drain the entire territory. The deep mines of Leadville are greatly troubled with water, and the most expensive pumps that can be constructed seem inadequate to protect the lower workings. By the proposed drainage tunnel not only will the expense of fighting water be done away with, but the economical operation of all the mines will be accomplished.

Transportation tunnels in mining districts are proposed upon smaller scales in nearly every camp in the State. As soon as a mine has shown by development that it is a productive property, with a continuous vein of ore of known value, the owners begin to plan a crosscut tunnel in order to reduce operating expenses to a minimum.—*N. Y. Sun.*

## THE RELATION OF MATHEMATICS TO ENGINEERING.*

MATHEMATICS has been described in this room as a good servant but a bad master. It will be my duty this evening to prove by suitable illustration the first half of the proposition, and to show the service mathematics has rendered and can render to engineers and engineering.

In our charter the Institution of Civil Engineers is defined as "A society for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of kuowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbors, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of co mmerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." No better definition can, I think, be found for our profession than that it is the art of directing the great sources of power in nature for the use and convenience of man. It covers all that the widest view of our work can include, and it excludes those applied sciences, such as medicine, which deal with organized beings. Mathematics has to deal with all questions into which measurement of relative magnitude enters, with all questions of position in space, and of accurate determination of shape. Engineering is a mathematical science in a peculiar sense. Medicine, the other great profession of applied science, has but little to do with questions of measurement of magnitudes, or of geometry; but the engineer finds them enter into everything with which he has to deal, and enter in the most diverse ways. The thing he has to determine is that the means he emplōys is enough and not unnec ssarily more than enough to attain the end in view. For this he must numerically measure the end and the means and see that they are justly proportioned to each other. It is useless this evening to waste time proving, what all will admit, that no one can be even the humblest engineer without a knowledge of arithmetic and enough of geometry to enable him to read a drawing, that some trigonometry, some rational mechanics and a knowledge of projections, is a very useful part of the mental equipment of a draughtsman. It is hardly necessary to call attention to the great economy in the labor of calculations effected by the use of logarithms, a mathematical instrument for which we are indebted to Napier. We may with more profit examine what use the higher mathematics can be to the practical engineer, and what has been done in the past for engineering by its aid.

Judging from etymology, mathematics must have been begun by engineers; for surely geometry is the work of the earth measurer or land surveyor. But since the prehistoric times when geometry was initiated, engineers have not added much that is new to mathematics. They have rather sought amid the stores of the mathematician and selected the handiest mathematical tool they could find for the particular purpose of the moment, but have done little or nothing in return in the way of improving the tools which they borrow. In this respect the relation of engineering to mathematics differs much from its relation to experimental physics. In electricity, magnetism and heat, engineers have from their practical experience repeatedly corrected the ideas of the theorists, and have started the science on more accurate lines. If our subject to-night had been the use of the practical applied science of engineering in promoting the development of pure mathematics, we should speedily find that there was hardly any material for discussion. The account being all on one side, let us see to what the debt of the engineer to the mathematician amounts.

There is no department of practical engineering in which the application of mathematics is more familiar than in that which relates to the calculation of the strength and rigidity of structures of various kinds. It is impossible to take up any book dealing with the subject without finding that it is crammed either with mathematical formulæ or with geometrical figures. The question is not whether mathematics is necessary to an adequate comprehension of the subject, but whether analytical or purely geometrical methods are more convenient. Of course one might occupy many lectures in discussing the practical application of mathematics to the question of bridge building, roofs, guns, shafting, and the like. Our object must be to illustrate by various examples, rather than to attempt anything like a complete discussion.

Consider the case of a long strut, so long that its transverse dimensions can be regarded as insignificant in comparison with its length. While the strut remains perfectly symmetrical about its middle line, its strength will depend only upon the resistance of the material to crushing. Every one knows that this would be an inadequate conclusion; we have to consider another element, namely, its stability, that is, we must examine what will happen to the strut if from any cause it is displaced somewhat from the direct line between its extremities. A mathematical discussion of the question results in a differential equation of the second order with one independent variable. Upon consideration of this we are enabled to see that if the thrust upon the strut be less than a certain critical value, a slightly bent strut will tend to return to its straight condition; but that if the thrust upon the strut be greater than this critical value, the displacement will tend to increase, and the strut will give way. Further, that the critical value will depend upon whether one or both of the two extremities of the strut are held free, or whether they are rigidly attached by flanges or otherwise, so that the direction of the axis of the strut at this point must remain unaltered. Again, we infer that if the ends are held rigidly fixed, the length of the strut may be twice as great for a given critical value of the thrust as if the two ends are free to turn. We can also infer what the critical value will be for struts of various lengths and of varying cross sections. This critical value depends, not upon the resistance of the material to crushing, but upon its rigidity.

Another example, having a certain degree of similarity with the case of struts, is that of a shaft running at a high number of revolutions per minute, and with a substantial distance between its bearings; for simplicity, we will suppose that there are no additional weights, such as pulleys, upon the shaft. How will the shaft behave itself in regard to centrifugal force as the speed increases? In this case, so long as the shaft remains absolutely straight it will not tend to be in any way affected by the centrifugal force, but suppose the shaft becomes slightly bent, it is obvious to any one that if the speed be enormously high this bending will increase, and go on increasing until the shaft breaks. In this case also we may use mathematical treatment; we find that the condition of the shaft is expressed by a differential equation of the fourth order, and from consideration of the solution of this equation we can say that if the speed of any particular shaft be less than a certain critical speed, the shaft will tend to straighten itself if it be momentarily bent, but that, on the other hand, if the speed exceeds this critical value, the bending will tend to increase with the probable destruction of the shaft. I do not know that either of these two questions can be properly understood without some knowledge of differential equations.

A problem having a certain analogy to those to which I have just referred is that of hollow cylinders under compression from without, such as boiler tubes. Whether the tubes be thick or thin, so long as they are perfect circular cylinders, they should stand until the material was crushed. But if the tubes are thin, what will happen if the tube from any cause deviate ever so little from the cylindrical form? The solution cannot be obtained without a substantial quantity of mathematics.

The next illustration shows how a mathematical conclusion, correct within the limits to which it applies, may mislead if applied beyond those limits, and how a more thorough mathematical discussion will give a correct result. Considering a case of shafting in torsion, it was shown by Coulomb that the stiffness and strength of a shaft having the form of a complete circular cylinder could be readily calculated if the transverse elasticity of the material and its resistance to shearing were known. From the complete symmetry about the axis it is evident that points which lie in a plane perpendicular to the axis before twisting will still be in that plane when the shaft is twisted; it is also clear that the angle through which all points in the same plane move will be the same; hence the problem was as simple as problem could be. But many who had occasion to make use of Coulomb's results gave them an application which was wholly unwarranted. They assumed that they were equally applicable to other cases than complete circular cylinders; they assumed, in fact, that every point of the material which lay in a plane perpendicular to the axis would remain in that plane when the shaft was twisted, whether the shaft was symmetrical about its axis or not, and they consequently arrived at very erroneous results. That the assumption was erroneous is obvious enough from a consideration of an extreme case. In Fig. 1 is shown

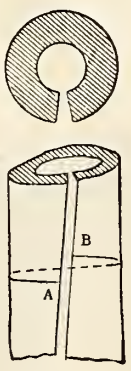



FIG. 1.

in cross section a hollow cylindrical shaft, which is not complete, but divided by a plane passing through its axis. In this case the shaft when twisted will be as illustrated in the side elevation; two points, A and B, were in one plane perpendicular to the axis when the shaft was free from twist; they cease to be in one plane when the shaft is twisted. St. Venant* in 1855 investigated the question of shafts without making incorrect assumptions; he expressed the condition of the material by a partial differential equation of the second order, and gave suitable surface conditions. A general solution of the problem for all forms of shafts has not been obtained, but St. Venant gives a number of solutions for particular forms, and he obtains some general results of interest. In all cases the stiffness of the shaft is less than would be inferred from an erroneous application of Coulomb's theory. Fig. 2 shows diagrammatically the strain in a shaft of triangular section; the full lines indicate that the parts of the shaft which lay in one plane before twisting

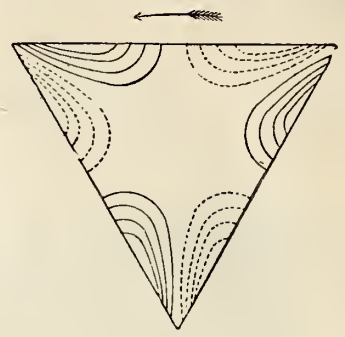


FIG. 2.

when twisted rise above the plane; the dotted lines indicate that they lie behind the plane of the paper. The shearing stress is least at the angles of the triangle, and is greatest at the middles of the sides. At this point then the shaft will begin to break under torsion. The fact is probably well known to men of practical experience, but it is directly contradictory to the conclusion at which one would arrive by a careless use of Coulomb's theory beyond the narrow limits within which it is applicable. The longitudinal ribs which one often sees on old cast iron shafts are useful enough to give stiffness to the shafts against bending, but are good for very little if torsional stiffness or torsional strength is desired.

Another application of mathematical theory which has been carried somewhat further than the premises warrant is found in the case of girders. It is almost invariably customary to treat a girder as though the sections retain when the girder is bent the form and size which they had before bending. Making this assumption, it is very easy to calculate the strength and stiffness of a girder of any section. Unfortunately, the assumption is untrue; but, fortunately, it is approximately true in the case of most girders with which engineers in practice have to deal. That it is untrue can be readily seen from consideration of a girder of exaggerated form, the section of which is shown in Fig. 3.

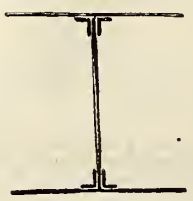


FIG. 3.

Any practical man would at once see that the outer parts of the flanges would add little to the strength of the girder, but according to the usual mathematical theory the outer parts of this flange should be as useful as the parts which are nearer to the web. This problem St. Venant also deals with in a rigid mathematical manner. Among other things, he showed that a girder of rectangular section, such as shown in Fig. 4, would, when bent, take the form shown by the

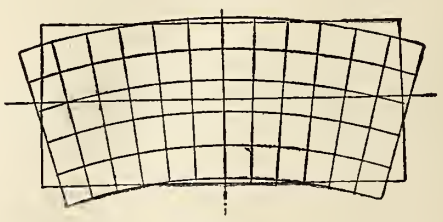


FIG. 4.

curved lines in the same figure. The last two examples show how a little knowledge may be a dangerous thing and how easy it is for any one who attempts to apply mathematics without adequate mathematical knowledge to be misled.

The theory of thick cylinders under bursting stress from within has many important practical applications to hydraulic presses and to guns. It has been discussed more than once in this room. As usual in considering these cases, we are immediately led to differential equations, which here are fortunately solved without serious difficulty, and the solution tells us the whole story. We learn that doubling the thickness by no means doubles the strength of the cylinder. And as a converse, that doubling the strength of the material will permit the thickness to be diminished to much less than one-half. Twenty-five years ago hydraulic presses were mostly made of cast iron. Many people were not a little astonished at the great reduction in thickness and weight which became possible when steel was substituted for the weaker material. In the case of guns it is well known that greater strength can be obtained if the outer hoops are shrunk on to the inner ones.* Mathematical theory tells us what amount of shrinkage should give the best results. It may possibly not be worth while to follow the results of theory precisely, but without the guidance of theory, it would not be unnatural to give so great a shrinkage that the gun would be weaker than if no shrinkage were used.

The rolling of ships in a seaway gives an illustration of a principle which has very varied application in many branches of physics. Suppose a body is capable of oscillating in a certain periodic time, and that it is submitted to a disturbing force of given period, the

* The "James Forrest" lecture, delivered at the Institution of Civil Engineers, by Dr. John Hopkinson, F.R.S., on May 3, 1894.—*Nature.*

* "Memoires des Savants Etrangers," 1855; and Thomson and Tait, "Treatise on Natural Philosophy."

* Lame, "Lecons sur la Theorie Mathematique de l'Elasticite des corps solides." 14th Lecon.

equation of motion easily shows that the resulting disturbance will be great if the two periods are equal or nearly equal. We meet with the principle in acoustics as resonance. If two tuning forks are tuned to the same pitch, and one is sounded in the neighborhood of the other, that other will presently be thrown into vibration by the waves transmitted through the air from the first. You may try a similar experiment at any time on any piano. Strike the higher G in the treble, the sound ceases on raising the finger. Now hold down the middle C, and again strike G; the C string at once takes up the note sounded, and can be heard after the exciting string has been silenced by damping. The same fundamental idea is found in the lunar theory in the term in the equation known as the evection, and again in the theory of Jupiter's satellites. The reason why the metals present in the solar atmosphere give black lines in the spectrum by absorption, corresponding in position with the bright lines in the spectrum which the same metals give when incandescent, is again the same. Gas will absorb or take in from the ether waves of the exact period which it is capable of giving to the ether. The general explanation of all these phenomena is easy. Imagine a pendulum, and suppose it experiences a periodic disturbing force, the first impulse of the disturbing force gives the pendulum a slight swing; the effect of the second impulse depends entirely on when it occurs; it may occur so as to neutralize the effect of the first, or it may occur so as to increase it. If the period of the force is the same as the natural period of the pendulum, the effect of the second, third, and later impulses will be added to the effect of the first and the final disturbance will be great, even though the individual impulses be minute. But the mathematical theory tells us much more than any general explanation can do. It tells us exactly what the character of the effect will be, and its amount, if the periods are nearly but not exactly the same. It tells us, too, exactly how friction affects the results. And the beauty of it is that the mathematical theory is much the same in all cases, so that having learned to deal with one case, we are enlightened as to a host of others. The oscillating body may be an iron-clad, or it may be an atom of hydrogen; the disturbing periodic force may be the waves of the Atlantic or it may be the waves in the ether occurring five hundred millions of millions of times in a second; it is all one to the mathematician; the treatment is substantially the same.

The question of the speed of ships and the power to propel them is probably more effectually treated by experiment on models, as was done by the late Mr. Froude, than by mathematics alone; but in order to learn from the experiments all they are capable of teaching, a mathematical understanding is needed. Given that we know by experiment all about a given model, that we know what force is needed to propel it at every speed, we want to know from these experiments how great a ship, 100 times as big, but similar in form in every respect, will behave; and here mathematics come in to aid us in making the inference.

The construction of ships at once leads us on to the methods of navigating them. In navigation I should find much material for my purpose, but navigation is not usually included in engineering, but many of the implements of navigation undoubtedly are. The mariner's compass has for ages been the mainstay of the navigator, and a simple enough instrument it was till it was disturbed by the iron of which ships came to be built. The disturbance of the compass by the iron of the ship was first seriously attacked by two senior wranglers, Sir G. Airy and Mr. Archibald Smith. The disturbance may be divided into two parts, the first due to the permanent magnetism of the ship, the second to the temporary magnetism induced by the earth's inductive action on the iron of the ship; the first causes the semicircular, the second the quadrantal, error. One has only to open the "Admiralty Manual of Deviations of the Compass" to see how the mathematics of Archibald Smith have accomplished a proper understanding of the subject. The errors of the compass are dealt with in two ways: they are compensated by soft iron correctors and by permanent magnets so placed to have an effect equal and opposite to the effect of the temporary and permanent magnetism of the ship. Or they are dealt with by formulæ of correction which enable the error to be calculated when the course of the ship and the conditions of the earth's magnetism are given, or a combination of the two methods is used. Either method is based on Archibald Smith's theory. It is not possible to leave the subject of the mariner's compass without referring to the great improvements of Lord Kelvin. The improvements relate to every part of the instrument, and I venture to say that none of them could have been made by any one but a mathematician. In order to get his card steady he knew that its period must be different to any possible period of the waves, or he would have the resonance to which I have just referred coming in, so he gave his card a considerable moment of inertia; but this was managed with a light card, so that small needles could be used. If the needles are small, the correction by soft iron masses and by permanent magnets is easier and more accurate. Then the bowl of the compass had to be suitably carried, so that it would not be unduly disturbed by shock, and provision had to be made for damping by fluid friction the oscillations of the bowl if they occurred. Lastly, a most beautiful method of correcting the compass, without taking a sight, was discovered. In every detailed improvement one can detect that the inventing mind was that of a most able and trained mathematician.

An essential of safe navigation is an efficient system of lighthouses. The optical problem of the lighthouse engineer is to construct apparatus which shall usefully direct all the light produced. The present forms of apparatus are in their leading features due to Fresnel, the able mathematician who established on an absolutely firm foundation the undulatory theory of light. To properly design an optical apparatus formulæ must be used, and the advantage is great if the designer can with ease manufacture the formulæ he requires.

*(To be continued.)*

THE energy exerted by a railroad train traveling 75 miles an hour is nearly twice that of a 2,000 lb. shot fired from a 100 ton Armstrong gun.

## THE BROTT ELECTRIC ELEVATED BICYCLE RAILWAY CO.

FROM time to time articles have appeared in the daily and technical papers regarding a projected electric railway between New York and Washington, but until quite recently nothing of a definite character has been given to the public.

On April 2 last, a bill was introduced in the national House of Representatives providing for the incorporation of the "National Rapid Transit Company," which bill was referred to the Committee on the Judiciary. We understand that favorable progress is being made in committee with respect to granting the company the charter it asks for.

The preamble of the bill recites the fact that it is evident that steam locomotion has reached its limit of speed, and that the practice of running passenger and mail trains on the same rails used for the transportation of freight is fraught with danger; that the proposed line will connect Washington with New York, be elevated and operated by electricity, and that a speed of 120 miles an hour or more can be maintained with safety and economy; and, further, that interstate commerce will be facilitated and the general welfare promoted thereby.

Section 6 of the bill provides "That the said road structure and its supports shall be made of iron or steel, of sufficient size and strength to permit the passage of cars on or over the same at a speed of one hundred and twenty miles an hour, and the conduits for the electric current to be so adjusted as to prevent any person from coming in contact with the electric current having sufficient voltage to endanger life, and that said roadway shall be elevated so that the tracks will be two or more feet above the ground, and shall be provided with one or more side rails at such elevation as will reach above the floor and under the sills of the windows of the cars (made to run on said structure) to prevent derailment, and in all other respects to conform to what is known as the Brott system for rapid transit railways; that when the said road passes through the streets of any incorporated city or village or over any public road or highway, it shall be either elevated sufficient for the passage of vehicles under the same or placed below the surface of the ground in such manner as not to impede the traffic of said city or village."

Section 13 provides that the capital stock shall be $15,000,000, which may be increased to $25,000,000 by a vote of stockholders. The shares to be $100 each.

Section 15 relates to the schedule of mail and passenger cars, which shall not be less than 100 miles an hour, and also provides that the charge for the transportation of passengers shall not exceed two cents per mile.

The Brott system, on which it is proposed to operate this line, and which is mentioned by name in the bill above referred to, has some novel features, which will be referred to below.

We are informed that tests have thoroughly demonstrated the feasibility and practicability of the system from a mechanical standpoint.

Water power being obtainable on the Potomac within a few miles of Washington, the company proposes to install a generating plant at a convenient point on the three-phase alternating system, generating current at a comparatively high pressure, and transmitting it either on a substantially built overhead line or in suitable terra cotta or iron ducts insulated in oil, as may hereafter be deemed most advisable, to the Washington terminus of the road. From this point it will form a part of the construction of the rail supports themselves, being carried in a proper manner under the main rails, with suitable distributing and equalizing mains carried under the side rails. A duplicate electrical plant will be installed, in order to insure continuous service all the time. Transformers of the step-down type will be used at frequent intervals, maintaining a positively uniform pressure at all points along the line. The Great Falls plant will supply current to the line from Washington to Philadelphia, another plant being located in the vicinity of Trenton, N. J., to feed the line in both directions to Philadelphia and New York.

Each car will contain four motors of the gearless type directly connected on the axles, two on the front wheel and two on the rear, and while of the multipolar type, will be constructed for high speed.

The motors will make 700 revolutions per minute under full load and will be directly connected to a steel driving wheel, built up in a laminated manner of sheets of steel, in order to get the highest degree of tensile strength, and resist the tendency to burst from centrifugal force. The car being built in the lightest possible manner, comparatively narrow, and pointed at both ends to reduce the air resistance to a minimum (when operated singly, the front and rear cars only being pointed when run in trains), will run at a normal speed of 2½ miles per minute. The weight of the motors will tend to greatly assist in the balancing of the car, aiding materially the traction, and yet permitting the car to rest freely upon suitable springs.

By means of automatic cut-outs, the line wires supplying current directly to the side collecting wheels are cut in sections of 2,000 feet each, every other portion of the line which is exposed being dead except that particular half mile on which the car is situated.

Where cars are run in trains all the motors are controlled by one motorman, in the front car, giving him absolute control of the movement of the train to a much wider extent than can be obtained in heavy and cumbersome steam locomotive and cars. One great advantage in the braking of the train is the fact that the entire current passes through the wheels into the rails, forming a momentary electric welding, which current, when permitted to flow so as to reverse the direction of the motors, enables the operator to bring his train to a standstill in less than one-third the time required by steam or air braking, and thus lessening the danger of accidents. This power of control, combined with the cradle in which the whole train lies, makes an accident of a serious character practically impossible.

The following is a brief statement of the main features of the Brott system:

The structure rests on a single line of iron posts, having a single supporting rail and side rails just below the car windows.

The cross section of this structure is U or trough shape, through which the cars run with great velocity without the possibility of derailment.

A double electric motor is adjusted to each supporting wheel of the cars, making each a traction wheel, and making it possible to ascend a 10 per cent. grade with ease.

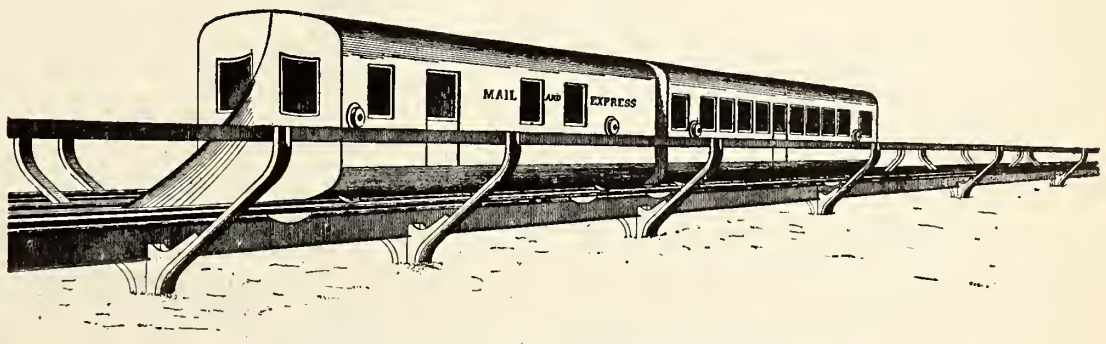
One side rail is charged with electric current, which operates the motors and thence passes through the driving wheel, to the main track, thus completing the circuit.

A train of cars on a steam surface road with a capacity for carrying 150 passengers will weigh over 200 tons, while a train of same capacity on the Brott elevated structure will not exceed 30 tons in weight, making a difference of 170 tons of dead weight which has to be carried whether the number of passengers be few or many.

In the Brott system there is a saving in the cost of operating and in cost of repairs; also time of transit and in land for right of way.

The average track elevation is about four feet, with more at road crossings and in cities, thus avoiding dangerous crossings, and the system is free from danger of washouts, snow blockades, etc.

The structure, which is made of iron or low grade steel, is indestructible, the estimated cost of which is about $20,000 per mile.




THE BROTT ELECTRIC ELEVATED RAILROAD.

When a double track is used the two are connected at the side rails in such manner as to add to the stability of the structure.—*Electrical Age.*

[Continued from SUPPLEMENT, No. 963, page 15392.]

## NICKEL—ITS HISTORY, USES, AND DISTRIBUTION.*

By A. G. CHARLETON, A.R.S.M.

### THE DISTRIBUTION OF NICKEL.

GEOLOGICALLY, nickel ores are usually divided into three main groups, which broadly correspond with the following classification.

Vogt has employed this subdivision as a foundation for a genetic classification. His groups are:

1. Arsenides, which include sulpho-arsenides and sulpho-antimonides, as well as combinations of the metal with sulphur and bismuth.
2. Sulphides, such as nickeliferous-pyrrhotite and pyrites, millerite, etc.
3. Silicates, garnierite, genthite, etc.

A brief description of a few typical examples of each group is interesting, as throwing light on the general occurrence of the ores of this metal.

The first of these groups is found in veins in Hungary, of the Dobschau type, and in the so-called Kobaltrucken, typified by the Richelsdorf Bieber veins. They occur also (as subordinate minerals) in the silver bismuth cobalt veins of Schneeberg, in the ordinary silver lead veins of Freiberg and in the Gem mine of Fremont County, Colorado.

In addition to nickel cobalt ores of various kinds, Von Groddeck shows that the typical Dobschau veins carry copper, and all these three metals are found in the serpentines and older eruptive lime-olivine rocks, which form "the country" of the veins, and appear to have been produced from the decomposition of the adjacent rock masses, composed of olivine and gabbro. A vein of this class is found at Dillenberg in Nassau, in pickrite, altered to serpentine, and contains millerite, bismuth-glance, pyrite, and other sulphide minerals. This vein was only productive in the serpentine, becoming barren when it passed into the adjoining schaalstein country.

The gabbro in the neighborhood of Dobschau, which has been partly altered, as before mentioned, to serpentine, is fringed by a peculiar green silicious schist, resting on gneiss and granite. The veins occur between the gabbro and the schist, do not possess well defined walls, and often reach a width of 25 feet.

The Schneeberg deposits, which likewise belong to this group, have a special interest for me, as I visited the district in 1880, and had an opportunity of examining its geological features, although my attention was more particularly directed to a study of the methods

* A paper recently read before the Society of Arts.—*From the Journal.*

of dressing these ores, which present particular features of interest in their details.

The veins chiefly occur in mica schist, which passes into clay slate, more rarely entering the deep-seated underlying granite, which, along with basalt, is found in intrusive masses, penetrating the overlying formation in the neighborhood of Schneeberg.

The chief group of nickel cobalt veins lies round Neustadtel, and, in general, strikes from N.W. to S.E., the dip being in some cases N.E., in others S.W., but in all cases highly inclined. The gangue is called, by Von Cotta, hornstone, and they carry, in addition to nickel aud cobalt, bismuth, copper pyrites, and silver. He considers them to be veins of infiltration, formed by percolating mineral waters.

Closely connected with this system of veins is an independent group of copper lodes, which strike N.E. and S.W., with an almost vertical dip to the N.W.

These show a great variety of copper and other minerals, among which may be named copper pyrites, bornite, copper-glance, tetrahedrite, cuprite, tenorite, chrysocolla, malachite, azurite, galena, cupreous sulphur of lead, cerusite, pyromorphite, iron and arsenical pyrites, blende, native silver, jasper alophane, dioptase, barytes, and brown spar—a veritable mineralogical museum. The nickel cobalt ores as they are delivered to the dressing works average, I was told, 4 to 6 per cent. of cobalt, 3 per cent. of nickel, and 8 to 10 per cent. of bismuth.

The second or sulphide group of nickel deposits embraces those of Sudbury, Ertali, Piedmont, Varallo, and other places, and possesses very wide distribution and marked geological characteristics. Vogt assumes this class of deposits is usually formed by a process of differentiation, or segregation from a basic eruptive rock-magma, and they are distinguished by the peculiarity that the ore chiefly consists of pyrrhotite, which carries, disseminated through its substance, various nickeliferous sulphide minerals, such as millerite, polydymite, and pentlandite, while chalcopyrite and titaniferous iron usually accompany the iron pyrites, as accessory minerals. The largest and best known deposits of this class are at Sudbury, in Canada, where the ore is found in irregular, lenticular masses in the Huronian rocks, apparently conformable to the planes of bedding, and invariably in proximity to dikes or uptilted sheets of greenstones (diorite) and diabase. From the fact that the greenstones themselves are found at times with ore disseminated through them, Merritt thinks the nickel has been brought to the surface by the agency of these dikes. The region has been much faulted, and in places the pyrrhotite and chalcopyrite form a breccia, in a dark, dioritic matrix. The main range is about 50 miles long and one to four miles wide, running N.E. and S.W. from Lake Wahnapitac to the Spanish River. The nickel deposit outcrops are described as forming hills or ridges.

According to Mr. D. W. Browne, the ore frequently loses the character of a copper ore, which it possesses at surface, becoming more and more nickeliferous and less cupriferous in depth. To illustrate this, he cites (New York *Engineering and Mining Journal*, September 16, 1893) the Copper Cliff Mine, stating that on the 4th and 5th levels the ore carries 4 per cent. of copper and 4·5 per cent. nickel, while on the 7th level many "stopes" show an average of 0·5 per cent. Cu and 8 to 10 per cent. Ni; the evidence, however, so far, would hardly appear to be sufficiently extended to warrant founding any general conclusions of similar enrichment, in other cases, taking place, founded upon what may turn out to be an exceptional occurrence.

As far as the Sudbury deposits have been exploited, down to a depth of 600 ft., there is no sign of falling off in the grade or quality of the ore. It contains in bulk 1 per cent. to about 5 per cent. Ni, and 1 per cent. to 4 per cent. Cu and cobalt; traces of gold and silver, and platinum, in the rare form of sperrylite (arsenite of platinum), is found in it. Ph. Argall, of Denver, in a most interesting paper read before the Colorado Scientific Society, December 4, 1893, gives the following analyses of an average month's output of the Copper Cliff, Evans and Stobie mines, to illustrate the ratios between the nickel and copper contents of the ore:

| | Copper Cliff. | Evans. | Stobie. |
|---|---|---|---|
| Cu | 4·31 | 1·43 | 1·92 |
| Ni | 5·57 | 3·74 | 2·36 |

A division of value is effected in the ore simply by screening. Thus at the Evans Mine it is found—

| | Per cent. Cu. | Per cent. Ni. |
|---|---|---|
| The coarse ore carries | 1·62 | 3·45 |
| The raggings | 2·99 | 3·90 |
| The fines | 3·78 | 5·04 |

The ore is sorted by hand into four grades—1st, the average mixed ore (nickel-copper); 2d, copper pyrites; 3d, pyrrhotite or nickel ore; and 4th, gangue. The closeness with which this separation can be made is shown by the following results:

| | Cu per cent. | Ni per cent. |
|---|---|---|
| *Mixed Ore:* | | |
| Copper Cliff | 5·67 | 4·75 |
| Stobie | 2·21 | 2·28 |
| Evans | 2·60 | 4·00 |
| *Picked Copper Ore:* | | |
| Copper Cliff | 14·13 | 2·74 |
| Stobie | 15·71 | 1·28 |
| Evans | 13·86 | 1·34 |
| *Picked Nickel Ore:* | | |
| Evans | 0·80 | 8·12 |
| Copper Cliff | 0·49 | 5·36 |
| Average diorite rock | 0·80 | 0·70 |

This table shows that the pyrrhotite carries the principal nickel value, in comparison with which the chalcopyrite is quite lean, and that these ores are not intimately admixed.

The report of the Ontario Bureau of Mines shows that 8 mines operated by four companies produced 85,790 tons of ore, which probably cost about $5 a ton to produce in 1891. The whole lot averaged 2·62 per cent. nickel; therefore the nickel in the state of ore cost about 10 cents per lb.

The cost of succeeding operations to produce one ton of nickel oxide, containing 76 per cent. of metallic nickel, may be estimated to be $140.74 dealing with these pyrrhotite ores. Its mining and transport can be reckoned at 10 cents per lb.; conversion into oxide, 9 cents; reduction into metal, 8 cents; and allowance for loss in working, 4 cents; total, 31 cents per lb.

Vogt endeavors to trace a constant ratio between nickel, pyrrhotite and chalcopyrite occurring in ore deposits in certain rocks, stating that while in each mine the ratio may vary from day to day, the ore ratio over a long period will give constant results. He gives a table showing the ratio for eight of the principal mines in Norway and Sweden. In them the copper contents corresponding to 100 parts of nickel vary from 20 to 80 and average 43; while the nickel and cobalt contents in 100 parts pure pyrrhotite vary from 2·5 to 7·5, and average 3·8. Thus he claims for ores produced by a segregative process, from one and the same eruptive, such as norite, there is a ratio between the proportion of nickel to copper on one side and the absolute nickel contents of the pure pyrrhotite on the other. The higher the nickel contents of the pyrrhotite, just so much lower is the ratio of copper to nickel. This phenomenon cannot have occurred by chance, but results probably from the relation existing between the small contents of Cu and Fe held in the silicates of the original eruptive magma.

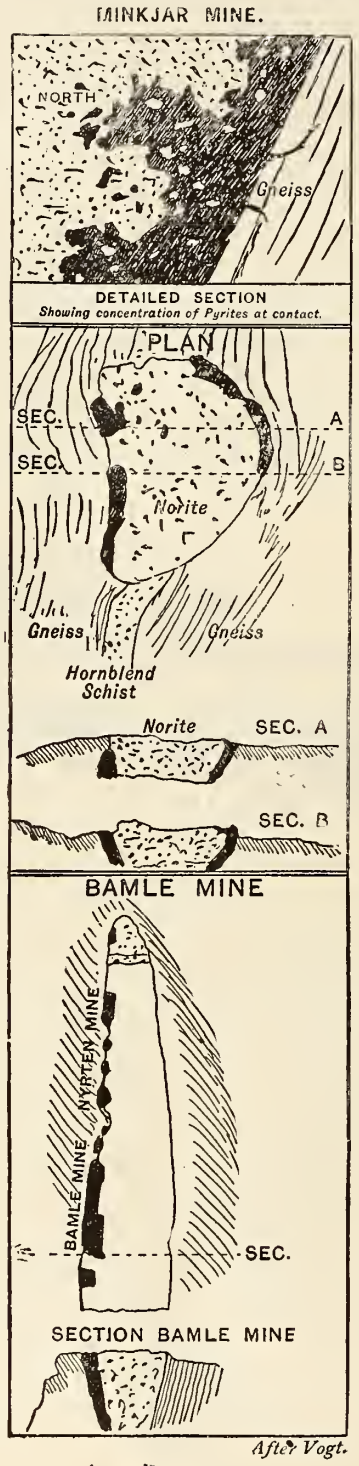



FIG. 1.

Mr. Browne has determined that the nickel exists in the pyrrhotite of the Copper Cliff and Evans ore, chiefly as pentlandite (Ni Fe) S, two-thirds of it being in this mineral form, and he ascribes the enrichment of the ore in depth to the increased amount of pentlandite found in the pyrrhotite of the deeper levels. He claims that the finer grained the ore is the more the nickel exists as an element, replacing the iron in the pyrrhotite, while experience has shown that the coarser grained the ore, and the deeper it lies below the surface, the more it occurs as pentlandite with the pyrrhotite.

S. H Emmons (New York *Mining Journal*, December 24, 1892) describes three new nickel minerals which he discovered in the Sudbury ore, viz., *folgarite*, found at the Worthington mine, having a composition represented by the formula NiS FeS; *blueite*, discovered in the workings of the Emmons Company's mines, composition $NiS_2$ ·12 $FeS_2$; and *whartonite*, found at a mine 7 miles southwest of Sudbury, supposed to have the composition $NiS_2$ 7 $FeS_2$.

In the Gap Mine of Lancaster County, Pennsylvania, we have another example of a nickel-sulphide ore, consisting of millerite associated with pyrrhotite, impregnating a lenticular mass of hornblende rock, embedded in mica-schist at or near their planes of contact. It has been suggested that this hornblende mass may prove to be an altered eruptive, while it is not unlikely that an adjoining trap dike had some influence in the formation of the ore body.

According to Blake, the ore runs 1·5 to 2 per cent. Ni, while Wharton averages it from a series of his analyses at 3·6 per cent. Ni and Co and 0·75 per cent. Cu.

For a third example, we may turn to the Norwegian pyrrhotite deposits, in which the ore occurs chiefly at the contact of the eruptive norites (massive hypersthene gabbros), with the archean country schists.

It has been pointed out by Stephen Emmons and others that the plane of contact between eruptive and sedimentary or metamorphic rocks offers a favorable passage for the circulation of mineral solutions.

A section of the Minkjar Mine (Fig. 1) represents a familiar ore deposit of this type, such as is usually assumed to have been so deposited. The norite body, shown in the general plan, is 243 ft. long by 135 ft. wide, and is almost entirely surrounded by an irregular deposit of pyrrhotite from 3 to 6 ft. thick. The detailed section illustrates the transition from a normal norite, first into pyrrhitiferous norite, and afterward into almost pure pyrrhotine, concentrated on the immediate contact of the gneiss, into which small veinlets occasionally branch off. Ore bodies are also found in the norite, along the contact of included masses of schist.

The third or silicate group of nickel deposits are best represented by those of New Caledonia, which have been described recently in a paper read by Mr. J. Garland before the Institute of Mining and Metallurgy, and by other writers.

Mons. Heurteau, I believe, made a detailed geological survey of the island in 1873, which led to mining operations being commenced.

The base of New Caledonia seems to consist of a light-colored non-fossiliferous schistose rock, on which secondary and tertiary rocks rest, and about one-third of its area appears to be covered by massive serpentines, which are most prominent in the east and southeast parts of the island.

According to Mons. David Levat (study of the deposits of Ni, Co and Cu in New Caledonia, *Association Francaise pour l'avancement des Sciences*, Paris, 1887), the nickel occurs solely in the form of magnesian hydrated silicates of a beautiful apple green color when pure, as coatings or concretions, in the fissures of the serpentine; and he concludes, from the absence of arsenides or sulphides of nickel, that their mode of occurrence points to the deposition of the ore from solution, in the state in which it is now found. The pure mineral, he reckons, often averages 26 per cent. Ni, but the average ore, after sorting, does not carry over 10 per cent. mixed with some serpentine gangue. Garland puts the average quality of the ore shipped to Europe at only 7 to 8 per cent. of metallic nickel, stating that ore of less than 6 per cent. is considered unmarketable and cannot be sold. The darker green the color of the silicates, the richer the ore seems to be, some specimens appearing to shade off into almost pure silicate of magnesia, which are almost white, containing only traces of nickel. Mons. Peletan has found cleopters inclosed in crystals of the green silicate.

This green silicate is not, however, the only form in which nickel ore occurs in the district, as most valuable deposits are found of a brown mineral of nearly the same composition, which Mr. Garland states is generally the richer of the two. It seems to consist of green silicate, in which part of the magnesia is replaced by hydrated oxide of iron (limonite) which gives it this brown color. Treated with dilute hydrochloric acid, the iron is dissolved out, leaving the green mineral garnerite, which shows that the iron is not chemically combined, but merely mechanically associated with it. The deeper brown it is, the richer the ore is reported to be. This is remarkable, and points again to the fact before remarked, that association with iron appears to affect the nickel contents of the ore in a favorable way. This brown ore has a very light specific gravity, only 3·00, and Claudet gives an analysis of it as follows:

| | | |
|---|---|---|
| Oxide of nickel (= nickel 9·64 per cent.) | 12·25 | per cent. |
| Oxide of iron | 32·20 | " |
| Magnesia | 3·07 | " |
| Alumina | 3·62 | " |
| Silica | 34·80 | " |
| Water at 212° Fah. | 6·43 | " |
| Water above 212° Fah | 7·07 | " |
| | 99·44 | " |

The percentage composition of both the green and brown minerals varies greatly, and the above analysis may be presumed to be below the average, as Garland states that, omitting minor constituents, the average of 12 analyses of the green garnerite made by Prof. Liversidge shows $SiO_2$ 44 75, NiO 19·73, MgO 15·25; and the government year book for 1891 states that the richer mineral has sometimes the following composition; Silica, 45; nickel, 26, magnesium, 13; iron, 3; water, 13. I am also informed by Mr. Gregory that he found millerite in a sample of the ore from New Caledonia.

According to Levat the massive serpentine itself contains nickel in proportions varying from 1 to 3 per cent., and in some cases even 5 per cent. He further inclined to the belief that the protoxide of iron of the serpentines diminishes as soon as the nickel appears in them, and the total of the two metals remains constant, but when his paper was written he had not had the benefit of a microscopical examination to determine this. He lays great stress on the fact that the nickel ores, though found exclusively within the serpentine area, are not distributed there in an arbitrary manner, but always occur at, or in the neighborhood of, certain beds of red clay (vasques), which Mr. Garland describes as looking in the distance like huge scars on the face of the hills. Levat says they appear black in the center and red at the edge, when seen in the distance from the sea, and they are often ranged one above another like stairs on the flank of the hills, giving a most characteristic profile. The former observer, however, denies their argillaceous character, stating that they contain practically no alumina, but consist almost entirely of iron and silica, with 1 to 3 per cent. of nickel, and he gives two analyses in proof of this contention.

The existence of these basins of red clay, or earth, as

they might perhaps (from what has been said) be more properly called, is certainly a most curious feature in the geology of New Caledonia, scarcely less extraordinary than that of the red pigs, for which the island is said to be famed, and possibly the color of the latter may have some connection with the presence of these red deposits on the island. So much of the island appears to be colored red by nature that it seems quite a pity in fact it is not red on the map.

The clays or earths are believed by Levat to be the products of the hydrothermal decomposition of the serpentines, as they contain all the elements of these rocks, in addition to iron, manganese, chromium, and cobalt. He supposes that numerous iron and manganiferous springs found vent through fissures in the serpentine and have eaten it away, leaving half dissolved masses of so-called sugar rock in the clay that fills the basins, which in many places are capped by a deposit of oolitic iron ore, the product of the overflow of the ferruginous waters. Mr. Garland's observations that the ore is found in massive pieces in botryoidal, mammillated, and occasionally in stalactitic forms, and in brecciated masses, supports this view. It has been pointed out also as a remarkable fact that these deposits are mostly found at high altitudes (the mountains of the interior rising to a height of 5,576 feet, and averaging 1,640 feet), and in the lower-lying serpentine areas they are non-existent, but I think it is capable of explanation, if we suppose that the serpentines are the altered products of volcanic action which overflowed in the interior of the island, as it is just there that the conditions would be found most favorable for the deposition of the minerals we have under review, under such circumstances. Veins of chrome iron ore also occur in the hard unaltered serpentines of New Caledonia,* while cobalt ore is likewise found in the red earths, the origin of which latter deposits is considered by Levat to be essentially hydrothermal. The chromium, on the contrary, he thinks, pre-existed in the serpentine, and was derived from it, while the nickel solutions only appeared after the deposition of the clay.

These solutions, circulating not only on the contact, but in the cracks and joints of the adjacent serpentine, would explain the deposition of the hydrated silicate of magnesium and nickel, in "Stockwerk form," which is the most usual mode of occurrence. The nickel ore is, however, also largely found, according to Levat, in a brecciated form on the roof or walls of the basins of red earth, being sometimes symmetrically deposited, when the axis of the basin is vertical (in which case the ore is of equal thickness on the walls); at other times the axis of the basin is inclined, and the serpentine which forms the roof is fissured, the cracks so found being often several meters wide, filled with rich ore, the nickeliferous solutions, being unable to penetrate the clay, finding a natural passage along the walls of the cavities. Where the circulating waters moved for a long time between the walls and the clay, fine striæ are found upon the latter (*Annales des Mines, second livraison*). Levat further states that the nickel deposits lie in a series of zones, running northeast and southwest, starting from the east coast, penetrating into the interior, and continuing, as Mr. Garland points out, to the west coast; outside of them there are only local encroachments, which lack uniformity.

Though in 1887, at the time Levat examined them, the deepest workings were only down 275 feet below the outcrop, he concluded that in depth they would lose their thickness, basing his opinion on the probability that the red earths with which they appear connected would not hold down to any great depth. Levat summarizes the general characteristics as follows: 1. The ore is essentially dependent on the serpentine of the east and southeast parts of the island. 2. Ores of cobalt, associated with manganese, are found in beds on the rim of the basins of the earth found traversing the serpentine in a number of places. These cobalt ores do not contain over two or three per cent. of Co, but they are very extensive, being mined simply by scraping up the material. 3. The deposits of chromium are of two kinds, either in veins in the serpentine or in stratified beds in the basins of earth. 4. The nickel deposits are of later formation than either of the two preceding ones, and are situated exclusively at or in the neighborhood of the contact of these clays or earths with the serpentine, and never in the body of the former. They are united in a certain number of northeast and southwest lines, the width of which does not exceed, as before said, 600 meters.

The crystalline dialage, being less attacked than the other constituents of the serpentine by the mineral solutions which have eaten it away, forms a skeleton, which is sought for by the miners as an indication of ore.

True lodes appear to be absent, but some of the fissures filled with ore can be traced for considerable distances along their strike, possess regular walls and dip, have a width of 18 inches to 5 feet, and have been followed down, in one instance, to a depth of 360 feet below the surface outcrop.

As the formation of the deposits in the basins of red earth is due, Levat thinks, to the shrinkage of those clays, their continuity in depth may probably depend, as he supposes, on the depth of the clays in the basins. It must not be supposed, however, that these deposits are likely to be speedily exhausted, as they have a very wide distribution indeed. They are mined in open quarries, in benches, when found as stock works; at other times, by tunnels and winzes. The work is commenced by removing the red clay, which, if mixed with the ore, entails difficulties, as the grains of iron are with great difficulty separated by washing, and consequently appear in the matte produced. Moreover, the clay, being very aluminous (according to Levat), renders the siliceous ore still more refractory.

The gravity system of transport on a single rope at these mines is certainly extremely primitive, but is no doubt due to the necessity of frequently shifting the position of the terminals. It might, however, be improved upon by hauling up the empty bags and carriers on a carriage attached to the main cable by means of a small hoisting rope, operated by a windlass, instead of carrying them up, as is now done, on men's shoulders. The principle of using gravity inclines with double ropes has been satisfactorily employed underground at the Pierrefitte mines in the Pyrenees, in large open gunnices; the only instance I know of where such a system has been operated underground. It was introduced because the flatness of the lode would have involved shoveling, and it possesses obvious advantages over an inclined plane, for a short temporary roadway in lofty workings.

According to Mr. Ph. Argall (quoting, I believe, from official sources), the output of nickel and cobalt ore from New Caledonia, in 1890, was 22,690 tons of (say) 10 per cent. nickel ore and 2,200 tons of 3 to 5 per cent. cobalt ore, while, in 1891, the output of nickel ore had only reached 35,000 tons. Mr. Garland states, on the other hand, that these mines are now producing over 60,000 tons of nickel ore per annum; and to reconcile the two statements, I take it that he alludes to the crude ore. He puts the cost of mining at 6s. to 40s. per ton.

The first mechanical treatment of the ore consists of sorting and washing at the quarries, where a division is made into rich ore, carrying 8 per cent. and over of nickel, and poor ore under that amount. The ore is then carried to the plain below to be washed, so as to remove the red clay. The nickel has the same specific gravity as the serpentine, but less than the iron. The ore rejected at the quarry, although it contains 3 or 4 per cent. of nickel, is of no value. Garnier's first idea was to treat the ore in a blast furnace, to obtain crude nickel and refine it; but this latter process presented such difficulties that it was abandoned. Fusion for matte was then tried but was also given up, owing to the high price of fuel and the inefficiency of the convict labor. The cost of producing metallic nickel, dealing with such ores, appears to be—mining and transport, 10 cents; conversion into oxide, 3 cents; reduction into metal, 8 cents; allowance for loss of working, 1 cent; total, 22 cents.

(*To be continued.*)

* At the Gasconne mine the serpentines are particularly rich in chromite, occurring in veins in the undecomposed rock, but breaking off suddenly at the contact of the serpentine and clay.

## THREE YEARS IN A COUNTRY GAS WORKS.*

By S. M. HIGHLANDS, of Clinton, Iowa.

I DO not think it is possible for me to add anything new to the gas industry, but I have long entertained the idea that the business was hedged around with too much mystery, and that the very conservatism that has been allowed to grow around it was one of the greatest drawbacks with which it had to contend. In the smaller cities the gas superintendent is alone, and in many places very lonely; and he is very apt to think his business a mysterious one; that he is the only man in the community who can master its intricate details; that all he has to do is just to wait until people come to their senses about the electric light craze, and everything will be serene.

It occurred to me some years ago that this was all a mistake; that educating the general public against their convictions is a slow and unprofitable proceeding; and that gas is only a commodity that people can either use or dispense with without very much inconvenience. And further, that the same methods that are most successful in other lines of business could be used to push the sales of gas, and with equal success. I fully believe that the unparalleled growth of the electric business was because of the efforts to make it popular, without regard to any immediate profits.

Infused with these ideas, I assumed the management of the Clinton (Ia.) gas works on April 1, 1891. The works were the usual 6 inch coal gas works and were built in 1871. In 1875 they sold 5,500,000 feet of gas. In 1884 it had increased to 6,122,000 feet. In 1886 the Thomson-Houston Company built an electric light plant and the sales of gas dropped to 5,892,000 feet, and in 1890 it had risen again to 6,491,000 feet, with the price of gas ranging from $2 to $2.50 per 1,000.

On April 1, 1891, the price was reduced to $1.75 for illuminating and $1.25 for fuel; and a contract was made for a set of water gas apparatus. At the outset of the new management, the old adage, "The money was made or lost in the retort house," was totally disregarded. The only aim was to make the kind of gas the public would use the most of, without much thought as to whether the gas was 16 or 24 candles, or whether it took 4 or 5½ gallons of oil, or 35 or 50 pounds of coal to the 1,000 feet. We believed then, as we believe now, that the principal duties of a gas manager were to sell gas, and that the making of it was a minor incident connected with the business; that the margin between the cost in the holder and the usual selling price was so great (greater by far than in any other large, legitimate business) that a manager could easily afford to have the cost increased by 10 to 15 per cent., if by so doing he could devote more of his time to selling it and thereby increase his sales. I will venture the assertion that there is not one manager here who believes he is selling one-half the gas the community would take and pay for, if he could only make it to their interest to do so.

In carrying out this idea, we advertised that for a year we would run free service pipes; sell gas stoves at cost; pipe buildings free; and in a great many places we furnished gas fixtures free. At this time the company had only 235 meters set and not a gas stove in use. By May 1, orders began pouring in on us until we had from 15 to 25 gasfitters at work, and during the summer sold 185 stoves and set 392 meters for illuminating purposes. This work cost the company about $4,000, and you can judge for yourselves whether it is worth this sum to add 577 new customers to a plant that only had 235 to begin with. By September 1, we felt strong enough to tackle the electric light company, and thought a fight with them would advertise us, if nothing else. We sent a canvasser to all their customers and offered to furnish them with gas for a year for half the price they were paying for electric light, generally allowing the customer to say how many gas jets he would need to properly light his place. They had 53 customers, and we took 45 of them on this proposition and had them tied up for one year. This action on our part forced them to sell out to us at once at our price, and we failed to have any fun out of the scheme at all. We metered the 45 contract customers just as carefully as we did the regular ones and took the statements monthly. It might be as well to state here that these contracts raised a new question in our minds that we will take up some time and settle to our own satisfaction at least.

Please remember that all this occurred in a small town, where the manager could be personally acquainted with each of his customers and know what they were doing; and this article is supposed to be of no benefit to the larger cities. Those 45 contract customers were put on without any idea of making very much money out of them, but rather to force a fight on the electric company. We knew when we took them that some of them would get pretty cheap gas, and we were not disappointed. During the year for which they run, they used 2,894,000 feet, for which they paid $2,171.06, or 75 cents per 1,000. In December they used 600,000 feet; and in July, 122,200; one of the largest customers fairly heating his building with it, and paying only 40 cents per 1,000, while some of them were paying as high as $1.50 per 1,000.

We bought the electric light plant in December, 1891, and immediately reduced the price of electric lights 25 per cent., making the rate for arc light of 2,000 candle power $6 per month, for 9 o'clock lights, and $8 for 10 o'clock lights, the gas contract customers having the option of surrendering their gas contracts and taking the electric light at the new price; but none of them availed themselves of the privilege. At the end of the year none of the contracts were renewed. About one-half of them are now using gas and the rest have returned to the electric light.

We found a great many customers who thought they could afford to use a gas stove, but were afraid to try gas for illuminating purposes; and for such customers we always put a gas burner over or near the stove and connect it with the stove meter. The result was that in a short time the man of the house would come to the office and say that he was tried of sitting in the kitchen to read, and wanted one light in his sitting room; and this was followed by several more in other parts of the house at the illuminating rate.

Our office is kept open from 7 A. M. to 9 P. M., and all complaints are taken care of within an hour of their being made. A meter prover is kept in the office; and when a customer thinks his meter is wrong we ask him to wait and see it brought in and tested. We are always willing to settle with him on the basis shown by the prover. I have yet to find the customer who was not perfectly satisfied after seeing this test made, and agreed with us that if there was anything wrong with his bill, the fault was at his house and not in our office.

Another imperative rule is that while we now have a monopoly of the lighting business, our customers should not find out that we know it; they should always be treated as courteously as they are in any other mercantile house; a trivial complaint should be treated with as much consideration as the most serious one. Another rule that will have more weight with them than all others is, whatever we do must be well done. Nothing temporary allowed, and never a makeshift.

In rebuilding the gas works, money was not spared to make it a good one. In rebuilding the electric light plant, the very best Corliss engines and high grade boilers were used. The results are that "no gas" complaints are rarely, if ever, heard, and we have not had a claim for rebate on account of "electric light out" for over two years. Our electric service has been so good that the city has just closed a contract with us for all their street lights for a period of 12 years, and the electric street railroad has contracted with us for its power for 7 years.

There have been no changes in prices on the gas for 3 years; and for the past 2 years we have been charging a fair price for all service work, also for all electric wiring and renewals. In the meantime, the growth of the gas business has been much more rapid than that of the electric business.

As I stated before, the company sold 6,491,000 ft. of gas to 235 customers in the year 1890. In 1891 they sold 11,432,000 ft. to 627 illuminating and 185 fuel customers. At this time—January 1, 1892—we had 50 commercial arc lights and 800 incandescent ones. For the year ending January 1, 1893, we sold 18,000,000 ft. of gas (an increase of 64 per cent.) to 940 customers, and in the year ending January 1, 1894, our sales of gas had increased to over 20,000,000 ft. to 977 customers; while the electric lights had only increased to 65 arcs and 1,200 incandescents, exclusive of the street lighting. With the street lighting and street railroad work, the gross business of the electric light plant is larger than the gas business, but is, of course, a great deal more expensive to us to furnish. On the whole, we are satisfied that proper business methods will push the sale of gas just as readily as that of any other commodity, and that without it the gas business is apt to cut a very small figure in small cities.

As some of you probably know, we also supply gas to Lyons, a city of some 7,000 inhabitants, immediately adjoining Clinton. Lyons has a municipal electric light plant that also supplies domestic lights. This plant has been established some 10 years, while the gas mains were only run 3 years ago. At the time we extended the gas mains there, nearly all the stores and shops were using the electric light. We did not make any effort to displace the electric light, but instead concluded we would see what a fair competition between gas at $1.75 per thousand and arc lights at $5.50 each per month would result in. For the first year or so we did not do a great deal of business with the stores. A customer would use the gas through the summer and then put back the electric lights in the winter when the evenings were long. In the summer of 1893 we sent 50 Welsbach burners up there to see what they would do. We equipped one large jewelry store with them at our expense and then waited for results. And they have been surprising, indeed; for to-day there is not one store in the city using electric lights, the Welsbach burners having entirely displaced them; but at the same time it has cut down our sales of gas, and I do not know but that we had better let a few of the electric lights come back, if we can only get rid of the Welsbach burners. The burners are all that is claimed for them, and give our customers unqualified satisfaction; but the confounded things won't let any gas through them. The same jewelry store that was formerly using two arc lights only used 3,000 ft. of gas in December. After our experiment with them at Lyons, we would prefer furnishing electric lights rather than Welsbach burners in Clinton.

* A paper read before the Western Gas Association, Cleveland.—*American Gas Light Journal.*

## BULLET-PROOF JACKETS.

OUR illustration (for which we are indebted to *La Ilustracion Española y Americana*) shows the trial which took place in the Winter Garden, at Berlin, on the 8th of April last, of bullet-proof jackets invented by Mr. Dowe. Many generals and army chiefs and the ambassadors of other countries were present at the trial. Rifleman Martin first discharged his gun against a horse covered with bullet-proof cloth. The animal received several charges without moving; not one of the bullets touched him. Afterward several soldiers loaded their muskets with regular charges, fired against a bust of plaster, which was protected with the cloth, and the bullets did not cause the least damage. Finally, the inventor himself covered his breast with a bullet-proof handkerchief of his invention and allowed himself to be shot at several times without being injured. Our picture shows this scene. The bullet-proof cloth, the dimensions of which can be seen in the engraving, weighs 18 pounds, but the inventor affirms it may be reduced one-half in weight; the thickness is two-thirds of an inch.

The Emperor William has shown great interest in this invention, and has promised to be present at some new trials.

Since Mr. Dowe's successful exhibits, Mr. Hiram Maxim, of London, has produced a bullet-proof jacket of analogous character, which he claims weighs even less than the German article.

Bullet-proof jackets have been made with steel plates inclosed in cloth. They are similar in general idea to the bullet-proof screens or boarding nets for war vessels, invented by Mr. Midgely, of Beaver Falls, Pa. These screens will arrest bullets fired from ordinary rifles, and thus give a protection to men on the decks of war vessels when in action.

THE RECENT TRIAL OF DOWE'S BULLET-PROOF JACKETS, AT BERLIN.

## VARIOUS USES OF WOOD.

THERE are countless ways in which wood is being consumed, besides the larger uses for fuel, building purposes, and the like; and in the aggregate these unconsidered uses amount to a serious drain upon the forests, while little or nothing is done to insure a supply for future demands. The enumeration of the special uses of wood in the arts forms a very interesting chapter. One of the principal uses of the wood of the holly, dyed black, is to be substituted for ebony in the handles of metal teapots, etc., and the strong, straight shoals, deprived of their bark, are made up into whip handles and walking sticks. The limetree forms the best planks for shoemakers and glovers upon which to cut their leather, and is extensively used in the manufacture of toys and Tunbridge ware, and by the turner for pill boxes, etc; and the inner bark is made into ropes and matting. The sycamore furnishes wood for cheese and cider presses, mangles, etc., and when the wooden dishes and spoons were in common use they were mostly made of this wood. It is now used also in printing and bleaching works for beetling beams and in cast iron foundries for making patterns. The yew is used by the turner and made into vases, snuffboxes and musical instruments, and it is a common saying among the inhabitants of New Forest that a post of yew will outlast a post of iron. Where it is found in sufficient quantities to be employed for works underground, such as water pipes, pumps, etc., the yew will last longer than any other wood. Gate posts and stakes of yew are admirable to wear, and in France the wood makes the strongest of all wooden axletrees. Of the beech are made planes, screws, wooden shovels, and common fowling pieces and muskets are also stocked with it, and beech staves for herring barrels are not unknown. The sweet or Spanish chestnut furnishes gate and other posts, railing, and barrel staves, hop poles and other such matters, such as strong and good charcoal, though scarcely equal to that of oak for domestic purposes, but considered superior to that of any other for forges.

Hornbeam is the best wood that can be used for cogs of wheels, excelling either the crab or the yew; but its application in this manner is about at an end. As a fuel it stands in the highest rank, emitting much heat, burning long, and with a bright, clear flame. In charcoal it is highly prized, not only for culinary purposes and the forge, but also for the manufacture of gunpowder, into which, on the Continent, it enters in large proportion.

In Russia many of the roads are formed of the trunks of the Scotch pine, trees from six inches to one foot in diameter at the larger end being selected for the purpose. These are laid down side by side across the intended road, the thick of one alternately with the narrow end of the other, and the branches being left at the end to form a sort of hedge on each side of the road. When thus laid the hollows are filled up with earth, and the road is finished, being analogous to the corduroy roads of North America. In Germany casks are made of larch, which is almost indestructible, and they allow of no evaporation of the spirituous particles of the wine contained in them. In Switzerland larch poles are much used for vine crops, they are never taken up, and see crop after crop of vines spring up, bear their fruit, and perish at their feet without showing symptoms of decay. The uninjured state in which larch remains when buried in the earth or immersed in water renders it an excellent material for water pipes, to which purpose it is largely applied in many parts of France. The butternut is esteemed for the posts and rails of rural fences in America, for troughs for the use of cattle, for corn shovels and wooden dishes.

Shellbark hickory provides baskets, whip handles and the backbows of Windsor chairs. The pignut hickory is preferred to any other for axletrees and ax handles. The sugar maple is used by wheelwrights for axletrees and spokes, and for lining the runners of common sleds. Dogwood is used for the handles of light tools, such as mallets, small vises, etc. In the country it furnishes harrow teeth to the American farmer, and supplies the harness of horses' collars, etc.; also lining for the runners of sledges. The mountain laurel is selected for the handles of light tools, for small screws, boxes, etc. It most resembles boxwood, and is most proper to supply its place. Bowls and trays are made of red birch, and when saplings of hickory or white oak are not to be found, hoops, particularly those of rice casks, are made of the young stocks and of branches not exceeding one inch in diameter. Its twigs are exclusively chosen for the brooms with which the streets and courtyards are swept. The twigs of the other species of birch, being less supple and more brittle, are not proper for this use. Shoe lasts are made from birch, but they are less esteemed than those of beech.

Immense quantities of wooden shoes are made in France from the wood of the European alder, which are seasoned by fire before they are sold. The wood of the locust is substituted for box by the turners in many species of light work, such as salt cellars, sugar bowls, candlesticks, spoons, and forks for salads, boxes, and many other trifling objects, which are carefully wrought into pleasant shapes and sold at low prices. The olive is used to form light ornamental articles, such as dressing cases, tobacco boxes, etc. The wood of the roots, which is more agreeably marbled, is preferred, and for inlaying it is invaluable. Of persimmon turners make large screws and tinmen's mallets. Also shoemakers' lasts are made of it equal to beech, and for the shafts of chaises it has been found preferable to ash, and to every species of wood except lancewood. The common European elm is used for the carriages of cannon and for the gunwales, the blocks, etc., of ships. It is everywhere preferred by wheelwrights for the naves and fellies of wheels, and for other objects. White cedar serves many subsidiary purposes. From it are fabricated pails, wash tubs, and churns of different forms. The ware is cheap, light, and neatly made, and instead of becoming dull, like that of other wood, it grows whiter and smoother by use. The hoops are made of young cedars stripped of the bark and split into two parts. The wood also supplies good charcoal. The red cedar furnishes staves, cigar boxes, stopcocks, stakes, and is also used for coffins.

A few special applications of wood in this country are mentioned, separated into trades—namely, sieves, usually of black or water ash for the bottom and oak or hickory for the circle; whipstocks, white oak; baskets, willow, white oak and shellbark hickory; picture frames, white pine and sweet gum; saddletrees, red maple and sugar maple; screws of bookbinders' presses, hickory or dogwood; hatters' blocks, sour gum; corn shovels, butternut; shoe lasts, beech and black or yellow birch.—*Carpenter and Builder.*

## AN AMATEUR'S PHOTOGRAPHIC LABORATORY.

WE very frequently receive letters from readers who write us that they wish to practice photography, and ask us to tell them what is the best apparatus adapted for a beginner, and what are the simplest, surest and best methods for the experiments to be made. Our correspondents are assuredly not aware of the difficulty of answering such questions. What is the most suitable apparatus? Well, the number of photographic apparatus has no limits; they are of all sizes and of all prices, from ten dollars up to a hundred. What are the methods? A description of these would be so extensive that it would form treatises of several volumes.

Still, we are anxious to give our readers information when they apply to our journal. An enthusiastic practician for many years past, we shall tell them what apparatus we employ, and describe to them the arrangement of our little laboratory and the preparations that we use therein. Coming into frequent contact, at Paris, with the most skillful operators, we have had recourse to their experience, and it is through following their advice that we have methodized matters. Beginners who wish to learn as amateurs will be able, we think, to imitate us with some profit. It is unnecessary to say that we have no other pretension

than that of guiding the first steps of those who ask for the first principles.

What apparatus shall we make use of? The photographic apparatus should be neither too large nor too small. Get an objective of fine quality, and do not look at the price too closely, for good results are obtained with good apparatus. Complete the objective with a shutter for taking instantaneous photographs. Employ sensitized plates of the first quality. Good instruments and good brands are now very numerous, and it is necessary to use them.

For an exposure during a promenade, we select the

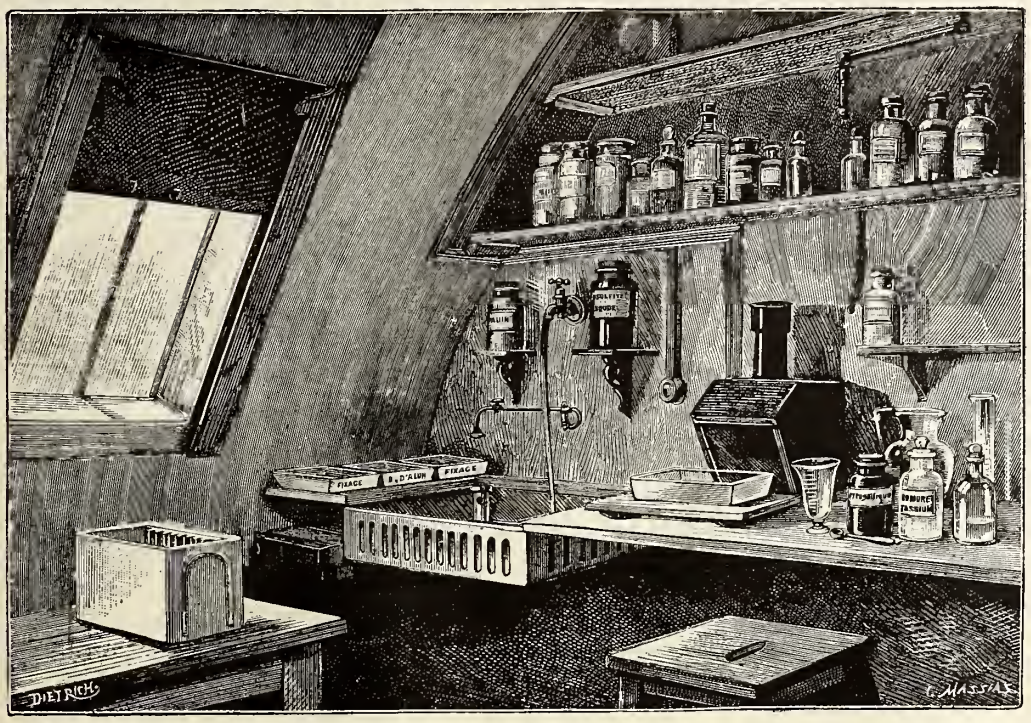



FIG. 1.—AN AMATEUR'S PHOTOGRAPHIC LABORATORY.

view that is most pleasing to take, with a good supply of light, the sun being behind us. If the sun is shining, we take an instantaneous view with a $\frac{6}{10}$ inch diaphragm and a rapid exposure. If the sky is leaden, we make an exposure of from one to three seconds, according to the extent of the landscape, and of about three seconds for a group of persons taken at a few yards' distance. After the impression of the plate, we come to its development.

The method of development that we have followed since our debut is the pyrogallic acid one. It is excellent, and permits of turning almost all negatives to account. It is well known and has been several times described by Mr. Albert Londe. It is as follows: Pyrogallic acid in powder, one mustard spoonful; concentrated solution of sulphite of soda and water, half and half; concentrated solution of carbonate of soda, a thimbleful; and bromide of potassium, a few drops. If the negative is deficient in intensity, we add some pyrogallic acid; if it is wanting in details, we increase the proportion of the carbonate of soda; if it comes out too quickly and we wish to moderate the development, we add some bromide of potassium. It requires much carbonate of soda for instantaneous photos, and very little for long exposures. After the development comes washing under a faucet, and fixing by means of a 30 per cent. hyposulphite of soda bath. The negative may be left in this without detriment, even after the fixing is finished. Next comes washing with a large quantity of water in a circulation tray.

The 5 × 7 inch apparatus needs a foot, and the carriage of it is sometimes inconvenient on somewhat lengthy walks. The amateur will do well to have another hand apparatus for instantaneous photography. We have successfully employed several apparatus in a trip through Switzerland. There are many excellent systems, but we cannot enumerate them all. With instantaneous apparatus, the amateur will do well to operate only under a sunlit sky. The results are often defective when the sky is overcast.

Our laboratory is modest in size. It is in a small Mansard room, but there is nothing wanting in it as regards equipment. It is darkened by means of a spring roller blind, which effects a hermetical closing. It is provided with a lantern having red and yellow glasses, and that contains a small kerosene lamp. The water enters through a cock above a sandstone sink provided with a constant-level safety closer. A second cock, terminating in a rose, permits of obtaining a shower of water for washings. Fig. 1 shows the appearance of this little laboratory. To the left we see the sink with its two cocks, and on one side the fixing and alum baths,* and on the other side the lantern and the developing bottles. In front of the window is the washing trough. The part of the laboratory not shown in the engraving comprises a laboratory furnace with its hood and its gas apparatus, and a table with scales, one of which is an instrument of precision. The tables are formed of enameled volvic lava, an excellent product and a very valuable one from the view point of laboratory cleanliness.

Fig. 2 shows the developing accessories. For holding the solutions, we use bottles provided with glass labels. A yellow glass jar contains the pyrogallic acid. The tray that we use is placed upon a rocking board that permits of agitating the developing liquid. Alongside of the pyrogallic acid jar is the wooden spoon that permits of dipping out the liquid. Near the tray we observe the hooked nippers that serve for lifting the submerged negatives, and alongside stands the graduate used for preparing the developing bath.

We recommend amateurs to exercise much care and cleanliness in the laboratory, and to let there be no upset liquids or stains. With dexterity it is possible to develop with pyrogallic aid without blackening the fingers.

We repeat, in concluding, that we give here only the methods of a practician who confines himself to an installation for an unpretentious amateur. The reader who wishes to devote himself to photography will perhaps find therein a few data useful for his debut.—*Gaston Tissandier, in La Nature.*

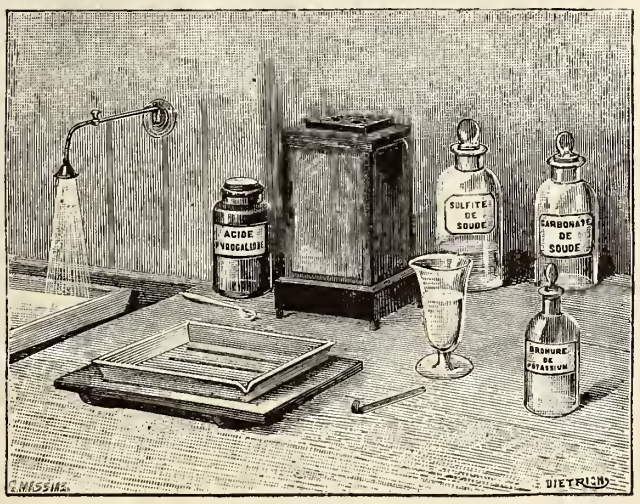



FIG. 2.—DEVELOPING APPARATUS.

## GOLD MOIRE-METALLIQUE.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry in the University of Sydney.

IN experimenting upon the reduction of gold from solution, to test the theories of the formation of gold nuggets, I found that the pure gold plates and foil which I used in many cases presented a moire metallique appearance, such as is so familiar to us in tin plate and galvanized iron. The whole surface of the plate became dotted over with more or less regular crystals like those often seen on tin plate; they are, however, much more regular and rectangular in outline and very small, the majority being less than one mm. square.

Afterward I found that this crystallization could be brought about by merely boiling the pure gold foil or plate in hydrochloric acid. The acid, although free from nitric acid, dissolved traces of the gold, probably due to a little free chlorine.

This moire-metallique gold may have been observed before, but I have not come across any reference to it. Advantage might be taken of it for decorative purposes on jewelry and other articles made of gold plate.—*Chem. News.*

* It is not a bad idea to immerse the negative in an alum bath before putting it into the hyposulphite solution.

## NOTE ON AN APPARATUS FOR THE CONTINUOUS PRODUCTION OF NITRIC ACID.*

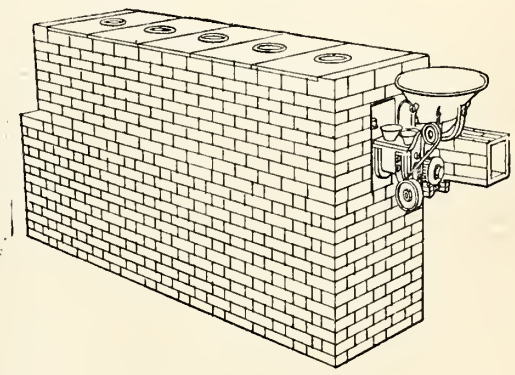
By MANNING PRENTICE.

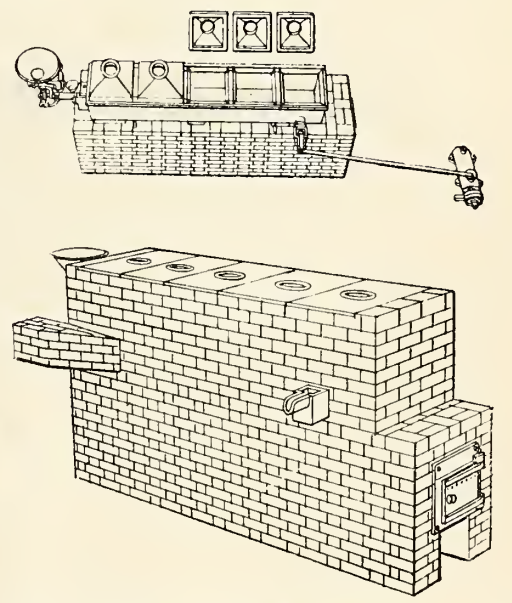
BY the kind invitation of the committee I have the honor to exhibit a model of the apparatus designed to produce nitric acid in a continuous manner.

As long ago as 1878 I carried to a very satisfactory issue experiments in the continuous distillation or rectification of sulphuric acid. The system of platinum pans which I invented was soon adopted by the largest makers of oil of vitriol, both in Europe and America, and the Prentice pan holds its own, in my opinion, to this day.

The great saving in fuel and general convenience of a continuous process is now so well recognized that you will not be surprised to learn that soon after patenting my platinum pans for the concentration of sulphuric acid, I began experiments with the object of discovering some method by which nitric acid could be produced without the loss caused by the alternate heating and cooling which occur in the ordinary process.

The difficulties seemed, however, insurmountable, and it was not until 1892 that I again took up this question and discovered important points which enabled me at last to solve the problem.





The model before you is an exact copy of the apparatus which has been working satisfactorily at Stowmarket for some time.

The nitrate of soda is placed in weighed quantities into the hopper, whence it passes (in the same manner as grain runs in a flour mill) to the feeder. This feeder is a miniature horizontal pug mill, which receives the streams of acid and of nitrate, and after thoroughly mixing them delivers them into the still, where, under the influence of heat, they rapidly become a homogeneous liquid, from which nitric acid continuously distills.

The still is divided into compartments or chambers in such a manner that the fluid may pass continuously from one to another. The nitric acid being continuously separated by distillation, the contents of each division vary—the first containing the full proportion of nitric acid and each succeeding one less of the nitric acid, until from the overflow of the last one the bisulphate of soda flows away without any nitric acid.

I may point out that while the ordinary process of making nitric acid is one of fractional distillation by *time*, mine is fractional distillation by space.

Instead of the operation being always at the same point of space, but differing by the successive points of time, I arrange for the differences to take place at different points of space, and these differences exist during one and the same points of time.

Experience has shown that there may be considerable variation made both in the proportion of sulphuric acid used and also in its strength, enabling one to obtain the nitric acid from the different still heads of varying strengths and varying proportions of acid of these varying densities. This is useful to those makers who require different acids for differing trade purposes.

It is also quite possible to produce the full product of nitric acid of the full gravity of 1.500.

* Read before the Society of Chemical Industry.—From the *Journal.*

With regard to the saving effected by my system, it has been found to exceed my expectations.

I now save more than two-thirds in fuel, also save four-fifths of the condensing plant.

One of my stills, capable of producing about four tons of nitric acid per week, weighs less than two tons; whereas (to produce the same quantity) two stills weighing five tons each were formerly used.

This saving of four-fifths of the weight of iron is accompanied by a corresponding saving in the cost of masonry.

There is also reason to believe that the life of my new still will be ten times greater than that of any previous still, for the destruction of the stills has been due to the alternate heating and cooling, with the consequent condensation of acid vapors within the still. This is, of course, entirely obviated by my continuous process.

I hope that my work in improving the process of production of nitric acid may be as useful to the makers of nitric acid as my improvements in the production of oil of vitriol have been to the makers of sulphuric acid.

## HOW TO LIVE AND RETAIN HEALTH AND VIGOR IN OLD AGE.

By NICOLAS PIKE.

THE casual observer cannot but ask himself the cause of so many sudden deaths of persons of both sexes, in middle life, which are reported every day. The mortality of late years has been extraordinary. To the mind of the writer it is easily accounted for, and as easily corrected; it is owing to the habits of life civilization has led people into, to the want of exercise, the inattention to the functions of the skin, the late hours of going to bed, and a long string of et|ceteras—all of which produce a lax, irritable condition of the membranes and fibers of the body, and a gorged state of the vascular system; a habit of body which is highly susceptible to the action of physical causes, and may be said to have a predisposition to run into disease, or which produces a full, plethoric habit of body that is little less so. If you wish to have health, it is necessary that you should be regular in your habits, have a stated time for your meals, eat sparingly of plain, nourishing food and leave pastry alone, abstain from ardent spirits and tobacco, retire from the dinner table feeling a little hungry; bathe often, and exercise in the opeu air when you can, as breathing the pure air gives life and strength; retire to bed early, as a good night's rest gives the body a chance to recover the nervous wastes lost during the waking hours. There is no doubt but sleep is a prolonger of life, and is upheld in a recent medical work on the digestive organs and faculties. The duration of human life may be ascertained by pulsation of the body. Say a man lives to 70 years, his heart beating 60 to the minute; the pulsations in that time foot up 2,207,520,000. If by intemperance or any other cause he raises pulsation to 75 a minute, the same number of pulsations is less in a sleeping than a waking state; it stands to reason that a long sleeper has a much better prospect of long life than a person who is satisfied with naps. It is well known that the great cause of our bodily ailments is repletion, that is, eating a larger quantity of food than is wanted to supply the necessaries of the system. A large number of persons are confined indoor, factories, counting houses, and workshops, with little or no exercise, and are deprived of the influence of a pure and unadulterated atmosphere. Such persons should pay great attention to diet, and should live in the plainest and most simple manner, taking but little of animal food. This will counteract the evils resulting from the mode of life they follow. The man or woman who is working at laborious, heavy work, breathing the pure air, would require a large quantity of solids to even sustain him; he could not do without it, as the nervous strain of the body requires it. The stomach then becomes the principal seat in which all ailments begin, which radiate through the whole system—a very essential thing, and one that can hardly be too much urged upon the attention of the thoughtful.

There is no doubt in my own mind that heart disease, Bright's disease of the kidneys, and many other diseases of a kindred nature, which are common at the present day, are caused by too much animal food. Our grandfathers and mothers, who lived to a good old age, subsisted on the plainest food, and were regular in their habits. They took time to eat and masticate their food; they were abstemious, and seldom made use of ardent spirits, with few exceptions. They were healthy and strong, and never indulged in late suppers or late hours. Fifty years ago, heart disease was seldom recorded. Why? Because their manner of living was plain, simple, and regular. Bread and butter, oatmeal cake, sweet milk, weak coffee, furnished their breakfast; sometimes boiled eggs. This was all. Their dinner was oftentimes pork and beans, with a good bread pudding or boiled rice. For supper, toast and tea, oftentimes oatmeal porridge. With this diet they worked all day on their farms, in shops and offices, and seldom called in a doctor.

They were strong and healthy. Look at the contrast at the present day. The breakfast in a fashionable and wealthy house is quite an elaborate affair. The dinner, with a course of many elaborate and made up dishes to tickle the palate, with wines and liquors of the choicest kind, strong coffee, with liquenr and cigars to terminate the banquet of three or four hours' duration.

At these gatherings wines and liquors are taken freely by both sexes. Now, as it is well known that alcohol acts on the human system as a stimulant, and excites all the organs of the body into preternatural activity, makes the heart beat quicker and stronger, causes the blood to be driven more rapidly through the system, and a greater flow of the various secretions for a time, so long as its influence lasts; when it is expended, there is none of its strength left to nourish or support the body, but, on the contrary, a degree of languor or exhaustion remains, as the consequence of the excitement that had preceded it. The stimulus has exhausted the vital energies, the nervous system is robbed of its power, and the mind, which depends on the nervous system for the manifestation of its powers, which is linked intimately to it, which is strong when it is healthy and ill when it is disordered, which sympathizes constantly with the state in which it is—the mind suffers, the mental powers pay the penalty of the wrongs inflicted on their material organs, of the goading and lashing to which they have subjected them. It excites and stupefies and indirectly wears out those who indulge in its use.

Is there any wonder that these gentlemen of leisure, who ride everywhere they go, and seldom take exercise, die suddenly? You can answer this question as well as myself.

The female part of the community who lead this life of pleasure, who indulge in late hours at balls and private parties, die a premature death; if married, bring forth puny children, who also die early. It is terrible to think of! A celebrated physician of New York once remarked in my presence that the wealthy men of New York would be obliged to marry with other races in order to perpetuate the species, as the present generation were fast dying out on account of their mode of life. This I believe, and I base my opinion on personal observations which I have noticed in families I am acquainted with.

In order to retain vigor in old age, one must take care of themselves when young. If you abuse nature, she will remind you of it in the downhill of life. Why do we see hearty, healthy old gentlemen, who have retained all their faculties at the age of 60 or 70? Such persons are frequently met with, who might pass for gentlemen of 50 years. If you should ask them to give you a brief history of how they have lived, they would answer, "Regularity in everything! in eating and drinking, plain and wholesome diet; early to bed and early to rise, abstain from all fermented drinks, and discard tobacco." It is very difficult to lay down a *menu* of what should be taken at breakfast, dinner, or supper, or how it should be taken. There are, however, general rules, and many kinds of foods which nourish the body generously. First it is absolutely necessary to be regular. Have a stated time for breakfast, dinner, and supper. Eat nothing between meals; do not wash down every mouthful of food with liquid of any kind. If you do, it will bring on indigestion. Always drink after you have eaten, if you require it.

Vegetables of all kinds are wholesome, and should be taken freely with your dinner. Fruit should only be taken at breakfast, and never at any other time. This is an old custom in the East, which has been followed, for centuries by the Chinese and East Indians, and where dyspepsia is unknown.

The more the stomach has to do in a given time, the less will it be fitted for further work; and if to a certain point and for a moderate time it has been allowed to repose from its labors, it will be in a much fitter condition for the exercise of its powers. Hence many articles of diet are digested without inconvenience when eaten in the morning, or in the earlier part of the day, that would by no means agree with the stomach if taken in the after part of the day, or in the evening. The best time for eating fruit is, therefore, for more reasons than one, in the morning or forenoon; at breakfast, or between that meal and dinner. During sleep, the earlier stages of digestion are much hurried, and the latter stages coming on prematurely, are performed imperfectly, and often with much inconvenience, and at times with no small disturbance to the system. Hence it is at no time more imprudent to eat fruit than at supper, or worse, just before going to bed. The greater the amount of actual vigor that the system possesses, the more easy and quick will be the digestion of food. The more exhausted the bodily powers, the more likely an article of food will be to disagree. Hence the very worst time at which fruit can be eaten is when the individual is fatigued; when the powers are exhausted, no matter how, whether by mental labor or bodily exercise or excessive heat. By attending to these points, it will be found that many can eat fruit with impunity and without risk who could not otherwise have done so. But there is an essential thing still to be mentioned, one that can hardly be too much urged on the reader's attention. It is that the quantity eaten be moderate; be rather less than the stomach could take without inconvenience than more than it could comfortably digest. The skins and seeds of fruits should never be eaten.

It is well to take meat only at dinner, and this meal should be taken in the middle of the day.

I will give an account of a few old people I have interviewed, and their mode of life, in my opinion, is the cause of their longevity. *Miss Hermond*, aged 102 years. The faculties of this lady were remarkable, eyesight, memory, and general health excellent. She stated that, when a girl, she lived on a farm, attended a country school till she was fourteen. Her father being a farmer, she worked home, milking cows, making butter, and doing general work about the house as a helping hand to her mother. Her mode of life was very regular. The whole family retired to rest soon after supper, and at the break of day could be found at their work in the house and about the farm. Breakfast at 7 o'clock, and consisted of oat and wheat cakes, butter and milk; sometimes fresh eggs, boiled or tried. *Dinner* always at 12 o'clock, which consisted of boiled or roast, sometimes fried meat, with all kinds of vegetables, which they used freely. Twice a week salt or fresh fish was served. A pudding, made of bread or rice, was the standing dish for "dessert." Sometimes pancakes were served. *Supper:* Bread and milk, milk toast, milk or weak tea. The only pastry they ever used consisted of pumpkin and apple pies. Pork and beans, with a suet pudding, was generally placed in the oven on Saturday night for Sunday's dinner, as her father and mother would not have cooking done on Sunday.

The above was the manner in which she lived for more than 70 years. Fruits which they raised were used freely by the family. The last twenty years of her life she has used oatmeal and other cereals for her breakfast; no coffee or tea—only warm milk.

This remarkable woman never called a doctor but two or three times in her life, and her sickness, she says, has always been owing to her own indiscretion, thinking she could do in her old age as she could when young.

*Captain H. W. Morton*, aged 97. This old gentleman was born near Marblehead, was hale and hearty, would row his dory a distance of a mile every day, to the fishing banks, without experiencing any fatigue. His faculties were excellent and his eyesight good; step regular and firm, voice clear, and might easily be taken for a well-preserved man of 70. He stated to me that his occupation had been that of a fisherman for 84 years. He had been a temperate man, both in eating and drinking, all his life. He was seldom sick, but had enjoyed good health since he was born. His food was simple and his habits regular; he was fond of sea food, which he made his principal diet, with a generous supply of vegetables of all kinds. Meat he seldom made use of. His meals were always taken at regular hours: breakfast at 7, dinner at 1 o'clock, and supper at 6. He retired to rest at 9 o'clock, and rose at daylight. He never called a doctor but once in his life; then it was to bandage his arm, broken by falling on the ice.

There is a gentleman in Brooklyn, 77 years of age, who is remarkably well preserved. He walks on an average six miles every day, when the weather will permit, and during the last year walked from Carlton Avenue to 103d Street and back, without feeling fatigue. To Coney Island and back is a morning's walk with him, when the weather is brisk and clear. For years he has accustomed himself to exercise in the open air, and has always preferred walking to riding. He is seldom sick, and, as a general thing, has enjoyed health nearly all his life, which has been a regular one, retiring early in order to give the body a chance to recuperate the nervous waste lost during waking hours. He is of the opinion that one hour's sleep before midnight is worth two hours afterward. Rising early in the morning gives one a chance to take the day by the forelock, whereby more work can be accomplished. Breakfast at 7 in the summer, in winter at 8 o'clock. This consists of oatmeal, well cooked, about 22 ounces in weight, with two soft-boiled eggs; a glass full of warm milk was all that was ever taken at this meal. *Dinner at 1 o'clock.* This consisted of fresh fish and all kinds of sea foods, which he prefers; beef and mutton (the latter preferred) was served about three times a week; not more than 4 or 5 ounces of this was taken at one meal. Game and poulty in the season and vegetables of all kinds were used in abundance. Rice or bread pudding for "dessert." Baked beans were served on Sunday for dinner, with rice pudding. Supper at 6 o'clock; oftentimes this meal was bread and milk; toast and *weak* tea or hot milk and water. No food of any kind was taken between meals. Coffee seldom made use of, as in early life it was noticed that it thickened the blood and accelerated the action of the heart. It is well known that anything that does this shortens life. Ardent spirits have been seldom used; smoking tobacco in early life, occasionally. In fact, the whole life of this gentleman has been temperate, frugal, and industrious.

M. Francisque Sarcy, the great Paris critic, has recently become a vegetarian, and feels the better for it. He says he is only a "moderate vegetarian," that is, he only eschews meat and admits eggs, butter, cheese, milk, and fish into his *régime*. Contrary to the expectation of both himself and his friends, he finds that he is in much more vigorous health and in better working condition under the influence of his new daily *menu* than before. At first he felt hungry an hour or two after eating, but after fifteen days the craving for meat passed away, and now he not only eats at the same hour as before, but consumes much less. The advantages of the diet are, he says, most remarkable. His mind is clearer, and his body more disposed for work; is no longer sleepy after meals, his brain is fresher, his limbs more elastic, and, more astonishing still, he has great resistance to fatigue. Formerly he felt the need of stimulants, now he has suppressed "*les petis veers.*" He does not smoke, and he is even endeavoring to diminish the quantities of coffee which he has been in the habit of taking. Altogether, he is very enthusiastic, and closes his dietetic confession by asking others to try his system.

It is the opinion of many of our scientists and medical men that the present generation dip too deeply into the flesh pots, or, in other words, eat altogether too much meat. Bright's disease of the kidneys and heart disease are, in the opinion of many, caused by this. We have, as an example, cases where animals are fed altogether with meat. They are not only short-lived, but are subject to diseases that man is heir to. Dr. Jaggar says the almost universal habit of feeding dogs with raw meat and to restrict house dogs to vegetarian diet, although such is not their natural diet, it might be supposed that the unnatural nutriment would disagree with them—but precisely the reverse is the case. Those fed on meat are in no way healthier than those fed on vegetable diet; on the contrary, the former have a disposition to eruptive diseases, digestive complaints, inflammatory disorders, hemorrhoids, and do not live long. It is a well known fact that many tribes of North American Indians are great consumers of flesh, and the result is, they are short-lived. They are subject to many diseases; smallpox sweeps away thousands of their number; kidney, lung and liver complaints are very common with them—diseases which hardly ever occur with the large rice-eating population of the East, or others who make a generous use of vegetable diet. Moral as well as physical life is largely directed by the food we eat, and it is safe to say that three-fourths of our bodily ailments and diseases are the legitimate results of improper dietetic habits. It is a physiological fact that our blood is made from the food we eat, and it is easy to understand that perfect food will create perfect blood, and may thus become the most effective medicine. It is generally admitted by authorities on the subject of diet that nitrogen is the most essential of all foods, and that a certain quantity should be taken daily. It appears that the diminution in quantity of food most frequently affects the nitrogen. Meat is the article of diet which, as a rule, is the source of the greater part of needed amount of nitrogen. At all events, meat is the popular article of food. Care, however, should be observed that too much even of this should not be consumed.

The substance most necessary for the preservation of life—the albuminoids—hold the foremost place, and the different kinds of fibrin, albumen, casein, are capable of taking the place of each other. The animal kingdom contains these substances in much greater abundance than the vegetable kingdom, but we can derive them from both. The herbivorous animals concentrate the albuminous substance of vegetables, and present to us nutrient matter. It is generally admitted by good authority on the subject of diet that nitrogen is the most essential of all foods, and that a small amount should be taken daily. The gray portion of gluten in wheat is a vegetable albminoid, differing in

no essential particular from the albumen of eggs and flesh, and is, consequently, rich in those nitrogenous and phosphatic elements which are equal to the repairs of the brain and nervous system and the muscular tissue. All foods we eat belong to one of the four following divisions: 1st. The starches. 2d. The fats. 3d. The albumens. 4th. The salts.

Dr. Sheppard says the uses of foods in the human economy are three: *First*, to build up and maintain the various tissues which compose it; *second*, to sustain the temperature at a proper degree; and *third*, to supply energy and force of action. The chief materials of supply for these three ends may be classified as: *First*, nitrogenized elements; *second*, hydrocarbonates; and *third*, carbohydrates; which, together with some inorganic principles, furnish all the requirements of foods.

In the last ten years I have interviewed more than fifty persons, male and female, that have arrived at the age of 90 and upward. Ten per cent. of these were over 95, and all of them, without a single exception, have been very regular in their habits. Plain food, such as they raised on their farms, was used—very little meat, and this only in the middle of the day, when the principal meal was taken. In all the interviews I have had with these old people, not one of them used much animal food for breakfast or supper, except eggs. Fish, butter and cheese—never pork, beef, or poultry. The cereals, such as oatmeal, wheat flour, rye and Indian meal; sometimes rice, when they could get it; milk, always in abundance, was on the table. Vegetables, which they raised on the farm, were always cooked and used freely. Also fruits of all kinds. Nearly all were temperate men and women; many never tasted spirits of any kind, and very few of the men ever made use of tobacco. All, without a single exception, retired to rest never later than 9 o'clock, and were early risers. Two-thirds of the number were brought up on farms, which they tilled; nine were professional men, doctors, ministers, and lawyers, who followed the manner of living which was taught them when young. Eight were fishermen, who were on the water a great part of their lives. By observing carefully the food taken by these old ladies and gentlemen, it will be seen that it was of such a nature containing a large supply of nitrogenized elements, which, together with some inorganic principles, furnish all the requirements of food. This, together with an active, regular, and temperate mode of living, is the cause, in my opinion, of their longevity.

[Continued from SUPPLEMENT, No. 963, p. 15393.]

## THE ADULTERATION OF FOOD.*

By H. W. WILEY, Chemist of the United States Department of Agriculture.

*Sugar.*—The common idea that the grocer puts sand in his sugar is not borne out by the facts in this country. I doubt whether a single pound of white sand has been put into the sugar supply of this country in the last ten years. It is one of those popular fallacies which gain credence inversely proportional to their truth. The granulated and white lump sugars which are found in our markets are almost absolutely pure; as pure indeed as the utmost care in manufacture can make them. Occasionally a little flour or starch may find its way into the powdered sugar, but such instances must be exceedingly rare. Low grade sugars contain molasses and water as a result of the way in which they are made and dried. In the refineries, after the pure white sugar has been secured, the molasses therefrom is reboiled and a second crop of sugar crystals obtained. These form the so-called coffee sugars of commerce. In a like manner a third crop of rather light colored crystals may often be formed. By a combination of low temperature and high vacuum in boiling, and by a manipulation producing small crystals, a sugar can be made very soft, and, so prepared, it absorbs a good deal of the mother liquor in which its crystals grow. It is possible, in this way, to put on the market a fairly light colored and attractive sugar which may not contain more than eighty-five per cent. of pure sugar. This process of making low grade sugars is practiced chiefly with the product of the sugar cane. In sugar from beets the molasses and mother liquors are usually so highly charged with alkaline salts as to render the manufacture of low grade sugars, fit for table use, a very difficult matter. In this country, as is well known, the greater part of the sugar consumed is made from sugar cane. Of the 4,000,000,000 pounds which we have eaten in the last twelve months, probably 3,500,000,000 have been grown under tropical suns. The proportion of yellow, coffee and low grade sugars offered is, therefore, greater in our markets than in Europe, where the sugar beet supplies nearly all the sugar consumed.

*Sirups.*—In respect of molasses and sirups the bill of health is not quite so clean. The quantity of pure maple sirup sold annually is well calculated to make the maple forests of Vermont prick up their ears. A very little maple molasses mapleizes the whole jugful; a fact that makers and sellers have not been slow to learn. An extract of hickory bark imparts a misleading flavor to a sirup made from cane sugar and starch, and a patent has been granted by the United States protecting the discoverer of this process in the exercise of his invention. Judicious mixtures of glucose, sugar, sirup and maple flavor are the secrets of the marvelous expansiveness of maple molasses between the tree and the gullet.

"Golden drips," "honey sirups," etc., are names given to compounds made of refinery refuse, glucose and centrifugal cane molasses. The great base of all our table sirups is glucose made from corn starch. I am far from denouncing glucose as a dangerous ingredient in such mixtures. On the contrary, when glucose is properly made, it is both palatable and wholesome, but its sale as maple molasses or as refiner's sirup or as open kettle molasses is clearly fraudulent.

*Honey.*—Liquid honey is very largely adulterated with glucose. Of five hundred samples of honey bought in fifteen large cities and examined by the Chemical Division of the United States Department of Agriculture, nearly forty-five per cent. were found to be fraudulent. Of comb honey, only that is adulterated which comes in bottles or jars. A few years ago there was a popular impression, which I shared, to the effect that comb honey in the frame was adulterated, but no sample of this kind has ever come under my observation, and I am convinced that such a species of adulteration does not exist. Perhaps there is no class of food producers in the country whose business has been so seriously injured by adulteration as the bee growers. Many of them, however, do not seem to realize the magnitude of the frauds which are perpetrated against them. They have often been known to denounce, as attempts to injure their business, the statements that such frauds are practiced. Of late, since indubitable evidence of fraud has been presented to them, they have determined to use every means to end it.

*Coffee.*—Almost equally subject to adulteration is ground coffee. The high price of coffee is a special incentive to sophistication. In former days it was largely the custom to buy the green berry, and each consumer would do his own roasting. Now it is fashionable, not only to buy the roasted berry, but also to buy it in a ground state. Chiccory, roasted peas, beans, etc., are often found in large proportions in such preparations, and, in fact, it is somewhat rare to find a pure ground coffee. It might be held that such sophistication would end with the ground article, but such is not the case. The berries themselves have been imitated both in the green and in the roasted state. The moistened mass of chiccory, starch, pea meal, caramel, molasses, etc., is moulded into the proper shape, and, when dried, these imitations might easily escape detection when mixed with the genuine berries. Those who are so fortunately situated as to be permitted to live at home and regale themselves each morning with an aromatic cup of Mocha or Java scarcely realize what it means to drink a lukewarm concoction of chiccory and pea meal, bluish black in color, but decidedly yellow in flavor.

*Tea.*—Thanks to our customs laws very little tea is found in this country adulterated with foreign leaves. The chief adulterations practiced with tea are found in the use of spent leaves and in the practice of facing. The practice of facing consists in treating the leaves with some preparation designed either to increase their weight or to improve their appearance. Salts of iron and copper are often used for this purpose. Some of these facing materials are quite prejudicial to health, and such teas are best excluded from the breakfast table.

*Cocoa.*—Cocoa and chocolate are largely adulterated with starch and sugar, harmless in themselves, but far cheaper than the meat of the *Cocoa theobroma*. The natural oil of the cocoa bean is also often extracted, and its place supplied by a cheaper fat or left without an oil. These various preparations are offered under fancy names and with wonderful claims of excellence. But in general we may say that the food value of a preparation is not much improved by having it digested before it is eaten. Yet often we see it claimed for a given mixture that it has had all of its difficultly digested components removed and that these are replaced by others with which the gastric juice can have a veritable picnic. The digestible cocoas often belong to this class, and, perchance, may have little of the virtues of the original beans left in them.

*Canned Foods.*—Of canned foods I should like to say something, but it is difficult to select the little which can yet be said. First of all, the material of which the cans are composed is a matter to deserve attention. It is undoubtedly true that glass is the ideal substance for cans designed to preserve food products. But the first cost of these packages and the danger of breakage during filling and transportation exclude them from competition with tin in all except the choicest brands of preserved foods. Fortunately, tin is a metal which is not only troublesome to the tariff, but also resistant to most organic acids. It is acted on very slowly or not at all by most organic acids found in fruits, vegetables and meats. In some countries, such as Germany, the tin which is used in contact with canned foods is required to be almost pure, and to contain not more than one or two per cent. of lead. The most abundant adulterant of tin, as found in tin cans, is lead, and it is against the presence of lead that it is especially necessary to guard, inasmuch as the organic salts of lead, without exception, are poisonous. In this country of personal liberty there is no restriction as to the percentage of lead which tins used for canned foods may contain. We have found as high as twelve per cent. of lead in tin from cans which have contained food designed for consumption. Such a high percentage of this dangerous metal cannot fail to excite alarm. We have also found numerous evidences of erosion on the tinned surfaces exposed to the action of the contents of the can. The contact of the preserved goods with solder should also be carefully prevented, inasmuch as solder contains often as much as fifty per cent. of lead. It is very common, however, to find lumps of solder in the canned goods and also to find the solder protruding through the points of union of the can and cover so as to be exposed to the action of the contents.

*Copper in Peas.*—Equally objectionable is the habit of using copper salts to impart a bright green color to canned peas and other goods. The imported French peas are uniformly colored with copper. The addition of a little copper, in any vegetable which it is desired to keep green when served, has a happy effect in that direction, and fashionable cooks have not been slow to learn this. It is true that the quantity of copper which one would eat in a single meal where French peas are served would not prove greatly injurious, but on that large part of our population who are compelled to dine every day on truffles and peas interspersed with terrapin and champagne, there is great danger of the copper acting with accumulative effect.

I have already spoken of the danger which may lurk in preservatives, such as salicylic acid, but there is also an occasional source of danger in the development of nitrogenous bodies called ptomaines in preserved meats. These bodies may develop with astounding rapidity if a can of meat be opened, and not eaten for a day or two. An illustration of the fatality of the action of such bodies is unfortunately often found in the case of tyrotoxicon, a poison often developed in milk or cream.

The above will serve as illustrations of the more common forms of adulteration to which our foods are subjected. The idea might be formed from this array of facts that foods are almost all adulterated, and that it is extremely difficult to obtain anything pure. Newspapers love to magnify these accounts of adulteration. What I have placed before you has not been for the purpose of exciting a panic on the subject of foods. Much the greater part of foods which Americans eat is pure and wholesome. It is only the small quantity of adulterated food from which we should strive to protect ourselves. This exaggeration of the adulteration of food has been humorously portrayed by Burdette in a little scrap of rhyme, entitled

A VICTIM OF DELUSION.

Placid I am, content, serene.
I take my slab of gypsum bread,
And chunks of oleomargarine
Upon its tasteless sides I spread.

The egg I eat was never laid
By any cackling, feathered hen;
But from the Lord knows what 'tis made
In Newark by unfeathered men.

I wash my simple breakfast down
With fragrant chiccory so cheap;
Or with the best black tea in town—
Dried willow leaves—I calmly sleep.

But if from man's vile arts I flee
And drink pure water from the pump,
I gulp down infusoriæ,
And hideous rotatoriæ,
And wriggling polygastricæ,
And slimy diatomaceæ,
And hard-shelled orphryocercinæ,
And double-barreled kolpodæ,
Non-loricated ambrœilæ,
And various animalculæ;
Of middle, high and low degree;
For nature just beats all creation
In multiplied adulteration.

Even the conservative work of the Department of Agriculture in investigations of food adulteration, which I have had the honor to conduct during the past six years, becomes most highly sensational material when portrayed in the columns of a daily journal. In the *Philadelphia Star*, of recent date, appeared the following remarkable statement of the work of the chemical division:

"Glucose, it appears, is the greatest of all adulterants. It is used for making cheap candy, sugars, jellies and sirups. Apple sauce is pumpkin boiled in cider. It is said that the cheap confectionery and liquors are the articles most injuriously adulterated. Candy commonly contains much fusel oil and other poisons. Strawberry ice cream—a plate of it—often contains almost more fusel oil than five glasses of poor whisky. It is colored with red aniline dye. Licorice drops are usually made out of candy factory sweepings. Wine is frequently nothing but water with a percentage of crude alcohol from grain or the refuse of beet refineries, colored with burnt sugar, flavored with oil of cognac and given an agreeable woody taste with a little catechu. When one buys tea for $1 a pound, one is very likely to pay in reality $2 a pound, because one-half the quantity is currant leaves. Grated horseradish is sometimes composed of turnip. Flour is frequently weighted with soapstone. Sweetened water, sharpened with citric and tartaric acids and flavored with the oil of orange skin, makes orange cider. Real honey can be distinguished, under the microscope, by the pollen grains it contains. They have wonderfully beautiful forms and the very flowers from which the honey was obtained can be identified by the various exquisite shapes of these fructifying germs."

The above startling facts in regard to adulteration, which are attributed to the Department of Agriculture, are worthy of especial notice because not one of them was ever abstracted from any report of the department. Scarcely a single instance of the adulterations mentioned above has ever been observed and reported on by the chemists of the department. Thus it is seen that the popular idea of adulteration is really very much at fault, and this has been due largely to the exaggerated statements of presumably honest men who desire to call attention to the fraud and to prevent it by exciting the popular mind against it. The adulteration of our foods and drugs is certainly bad enough, but in my mind it does no good whatever to exaggerate, falsify and misstate the results of careful and unbiased investigations. As has before been intimated, in this address, the remedy against all these things lies clearly in the power of the people. Wise laws wisely administered, a careful system of inspection, a demand for pure food, will secure the people in their right. It is not the rich for whom we should work, but the poor, and they should be protected against frauds in food; frauds not so dangerous on account of being deleterious to health as because of their pretensions to furnish to the poorer part of our people a food ostensibly pure and nutritious, but in reality valueless. It is not supposed for a moment that any system of legislation can entirely prevent the perpetration of frauds upon the community, but at least these crimes can be made punishable and their perpetrators may be compelled to endure the penalty of their misdeeds.

* A lecture delivered before the Franklin Institute. From the *Journal of the Institute.*

## A PLEA FOR THE SUPPRESSION OF VICE.

AT the recent sanitary convention, San Jose, Cal., Dr. Geo. Childs Macdonald read a paper on the contagious diseases and their suppression by legal measures, in which he remarked: "I intend solely to deal with syphilis and the legal measures which could and should be enforced for its extermination. This disease is the most frequent of all human maladies and, although secret, is very wide in its influences, and, therefore, worthy of serious consideration. . . .

"In advocating prophylaxis I do not want you to understand that I am doing so in the interest of those who deliberately expose themselves to contagion—my plea is for those innocent ones who are the victims of cruel circumstances and for the material welfare of ourselves as a nation.

"There are many ways of inoculation, such as kissing an infected person, using the same fork, knife or pipe, sleeping in the same sheets on which a diseased

person has lain. dental and surgical instruments, vaccination, suckling a syphilitic child or an infected nurse suckling a healthy child. . . . Physicians frequently become inoculated by examining diseased patients; rag pickers of necessity are liable to infection, and so on through many and various conditions of life. But my plea becomes stronger when we consider the position of the young wife, the expectant mother and unborn child. It is easy for us to say that no man should marry who has acquired this disease, but how futile our warnings! . . .

"We are advocating the segregation of phthisical patients because of the tubercle bacillus; what of the bacillus of syphilis? Phthisis has slain its thousands, syphilis its tens of thousands. The bacillus of phthisis only attacks the inherently weak, those predisposed to its action. Thus tuberculosis becomes a factor in natural selection by which these weaklings are removed and prevented from propagating their infirmities. It is, therefore, so to speak, a regenerator of the race, while syphilis, attacking strong and weak alike, has no such selective properties, but its tendency is toward human degeneration, physically, mentally and morally. . . .

"It becomes the duty of all honest minded, intelligent men to throw aside a false modesty in this matter and stamp out the pest which we, as a race, have been harboring so many years, and to assist in obtaining legal enactments necessary. Such laws should be divided into two classes, viz.: 1. Those which apply to the community at large, including restriction against the spread of the disease, accommodation for treatment, etc. 2. Those which control the family and individual. Hospitals for this disease should be maintained at the expense of the State, in which these people should be received and kept until non-infectious.

"Every woman known to be a person of ill-fame should be duly licensed. She should be compelled to attend twice a week at some municipal building set aside for this purpose, where she shall undergo a proper medical examination by a physician appointed by the State. He should enter her name, address and description in a book as a means of identification, and indorse her license, such indorsement to hold good until next examination. Should she be found diseased, she should be sent to the nearest State hospital. . . .

"No male should marry or obtain a marriage license until he shall produce before the recorder a certificate from a physician stating that he is not contagious in a venereal sense, and that he has not contracted syphilis for three years past. All wet nurses should before entering on their duties obtain a certificate of health from the certifying physicians. All vaccination should be done solely by calf lymph.

"The system I advocate would bring all kinds and conditions of men under this law. These few remarks are but a nucleus to demand your serious consideration as guardians of the public health."

## THE LATEST EGYPTIAN DISCOVERIES.

SINCE the commencement of the century, in Egypt, more than in any other country, antiquaries and archæologists have dug and excavated so as to penetrate the mysteries of the history of the ancient races that peopled the land. The ground has been turned over, more or less, in nearly every district, and many a hitherto forgotten town or city has been brought to light, so that we might say that little has been left undiscovered which was worth discovering in the country between Alexandria and the cataracts on the Nile.

Of all the places in the Valley of the Nile, none has more often attracted the attention of explorers than the tract of country which has been called the Necropolis of Memphis—that spot in the desert which the ancient inhabitants of Memphis chose as a site for the tombs of their rulers, and where the kings of the ancient dynasties erected the pyramids which were to contain their mortal remains. In spite of their efforts to hide the actual position in each instance of the chamber containing the coffin, the iconoclastic explorer of this and other centuries has discovered them in the majority of cases, and the tombs have been rifled of their treasures. Many of the pyramids, as we all know, have contained objects of historical value, which have enabled archæologists to make discoveries of the greatest importance, while some of the other ancient monuments have hitherto added little of any value to the student of Egyptology.

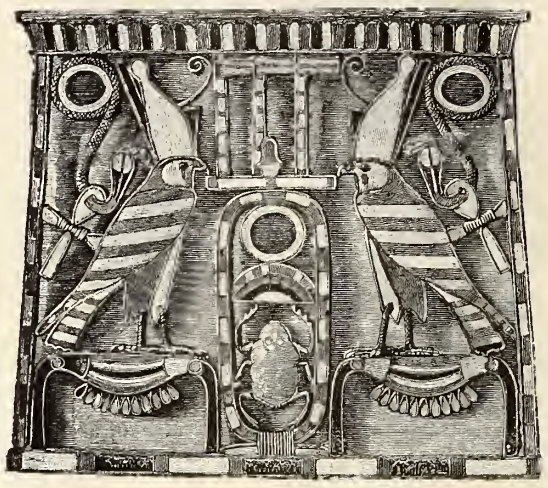
Until recently, the two brick pyramids of Dahchour (or Dashoor) might have been included among the monuments which were full of mystery, and which had hitherto not enriched the stores of nineteenth century knowledge. These pyramids are called by the Arabs the black pyramids, and they have excited the curiosity of travelers from the time of Herodotus, who said of them that they were even more mysterious than their sisters the stone pyramids.

At one time these brick pyramids had an outer covering of stone, but this was taken away by a well-known Egyptan conqueror, the famous Sesostris, who did not hesitate to denude these pyramids of their carved stone facings, so as to enrich and enlarge the beautiful temple of Ptah at Memphis. To-day the pyramids are little better than shapeless mounds, although a close inspection shows how well each pile had originally been constructed, and of what good material it had been composed, to stand so long after being deprived of its protecting stone covering.

So early as the year 1839, Mr Perring, who had been sent out on behalf of the British Museum, had attempted to cut his way into the more northerly of the two brick pryamids, but without result. The Egyptian government department which concerns itself with the discovery and preservation of Egyptian antiquities, a department founded by the French *savant* M. Mariette, the discoverer of many of the Memphis remains, has made several attempts to probe the depths of the mystery of the "black pyramids," and in 1884, under the direction of Mr. Maspero, an excavation on an unusually large scale was commenced on the north side of the larger pyramid. It was expected that the secret entrance to the innermost chambers would soon be reached. The work was continued for two years and was then given up.

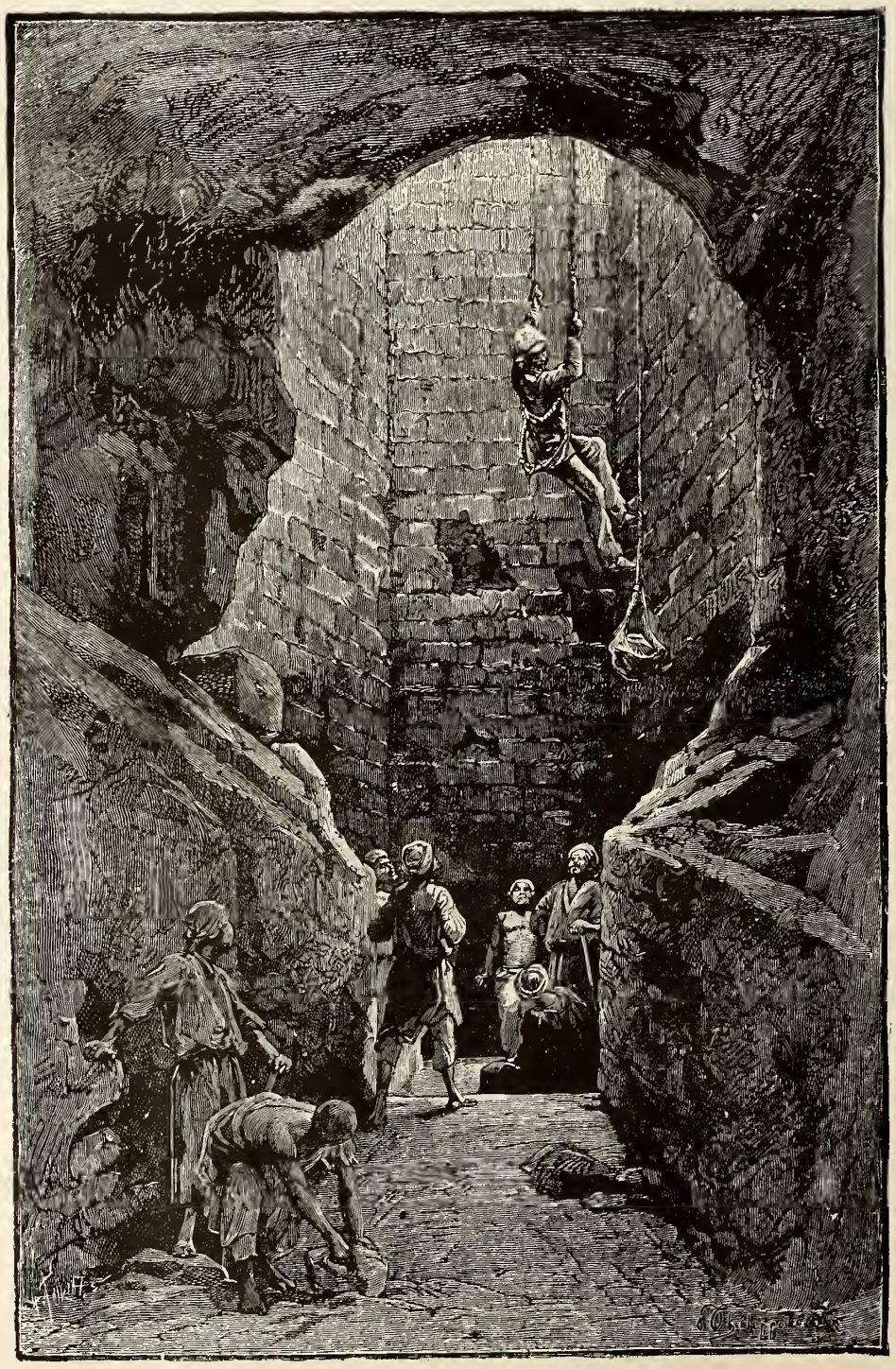
The new director of the department, Mr. T. De Morgan, being satisfied that the efforts of his predecessors had not been properly directed, determined to make a fresh attack on this mysterious and impregnable fortress of the dead. So in February this year he established himself at Dahchour, and shortly after his arrival some hundreds of fellahs were engaged to make excavations. The men dug the sand and filled the baskets for the women and children to carry off, the whole crowd singing all day long their peculiar songs, of which the words vary but seldom and the tune never. Mr. De Morgan commenced by excavating the tombs situated round the pyramid, by which he was enabled to make researches proving the period to which the tombs as well as the pyramids belonged. These tombs were the burial places of the richest inhabitants of Memphis who lived in the reigns of the kings who built the pyramids; the better class of people, and the courtiers, being able to afford to be buried close to the burial place of the kings. About thirty mastabas, as these tombs are called, were laid bare, among them being the sepulchers of several grand court functionaries known to students of ancient history, such as Khnoum-Hotep, Nebasi, and Out-Khent-Khiti. All the tombs were built on the same simple principle each being covered by a mass of stone masonry ornamented on the sides with sculptured funereal figures, while in each case the entrance to the tomb was from the north, whence a passage led to a pit more or less deep, in which the sarcophagus had been deposited. This was, of course, the mode of burial in vogue up to and including the Twelfth Dynasty. Among the royal names on some of the tombs were those of Osirtasen II., Osirtasen III., and Amenemha III., the principal monarchs of that dynasty.

As a result of his researches, Mr. De Morgan was able to prove that the large pyramid was built on a plan similar to the small tombs, for he set his men to dig carefully all along the northern base of the pyramid inside the outer surrounding wall, until one day his enterprise and patience were rewarded by the discovery of an entrance to a pit in which was an opening leading to a tortuous narrow passage. At the end of this passage was a tomb with a rifled sarcophagus—rifled by the spoliators of a bygone age, perhaps in the time of the Romans. This sarcophagus chamber led to a gallery about 120 yards long. The pit by which entry had thus been obtained into the pyramid was evidently not the true and original entrance, but a pit made by the people who had rifled the tomb of its



THE DISCOVERIES NEAR MEMPHIS—JEWELED BREAST-PIECE OF THE TIME OF OSIRTASEN II.

THE DISCOVERIES NEAR MEMPHIS—JEWELED BREAST-PIECE OF THE TIME OF AMENEMHA III.



MR. MORGAN NEAR THE BOTTOM OF THE WELL.

treasure. The difficulty now was to find the proper doorway. And this was all the more necessary since it was found impossible to remain inside the gallery without being suffocated, and an opening near the other end of this gallery would establish some ventilation which would enable the workers to carry on their explorations. At length the proper entrance was found. It led to twelve vaults more or less spacious, of which the contents—sarcophagi, offerings, canopies, carpets, etc.—had been stolen or rifled at some remote period of antiquity. Most of the objects left behind contained no inscriptions; but the few hieroglyphics remaining showed that the explorers were in the burial place of a family of high estate; in fact, of a whole series of princesses, and among them actually the coffin of the Queen Nofert-Hout, and the coffin of the royal daughter M nt-Sent-Senbetes.

But the discovery that placed the date of these burials as having taken place in the middle of the medium or middle empire, during the time of the most powerful dynasty of that period, was made a few days later. Mr. De Morgan was carefully clearing the floor of the passage when he discovered, under the spade of one of his assistants, a hiding place scarcely covered by the sand, and which had not been noticed by those robbers of bygone days who had rifled the tombs. In this secret receptacle was a little wooden box, quite rotten, filled with jewels of perfectly marvelous workmanship. This box was carefully conveyed to the museum at Gizeh. The principal jewel was a breastpiece of gold incrusted with precious stones of remarkable beauty and of very fine workmanship. On this was depicted two eagles guarding the tomb of Osirtasen II. The rest of the jewelry consisted of necklaces, bands, bracelets and scores of various little trinkets.

The following day the explorers brought to light, close to the sarcophagus of another princess, a still larger box of jewels, of which the principal were two breastplates, on which are inscribed the names Osirtasen III. and Amenemha III., while around the names the enemies of these two kings are depicted being thrown to the ground.

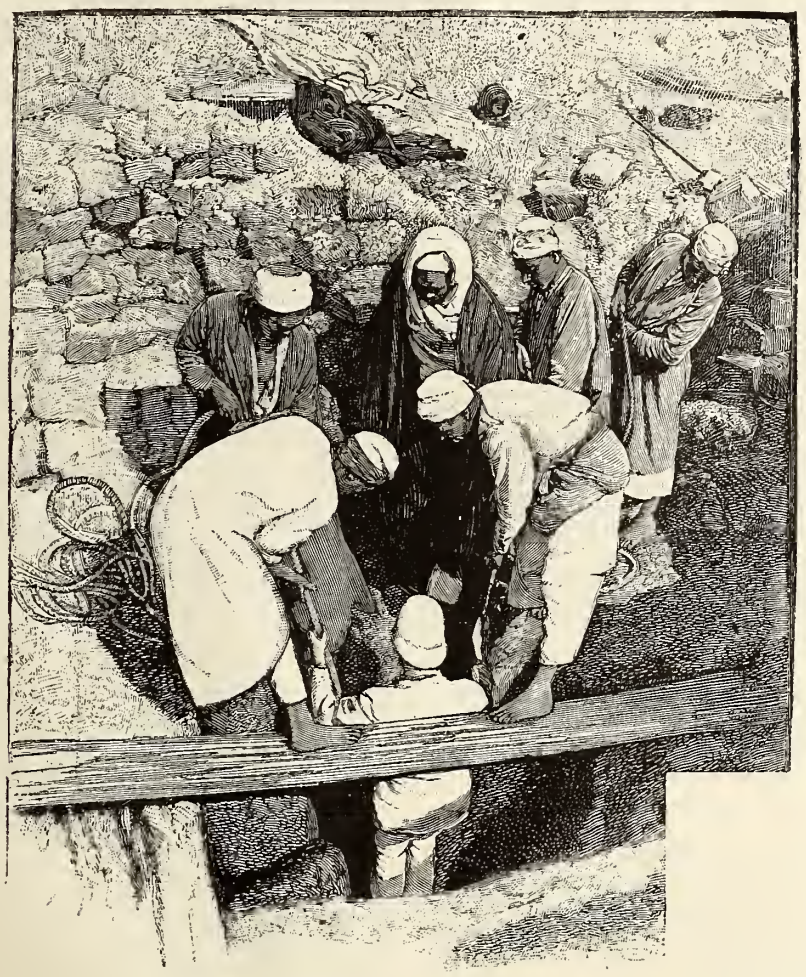
Encouraged by these finds, the explorers continued their researches, but as yet the vault containing the mummy of the king for whom the pyramid was constructed has not been discovered. Success will, however, crown Mr. De Morgan's efforts, which have been delayed by the mass of *debris* caused by the former excavators.

Since the discovery of the great subterranean passage, several other pits have been cleared of sand, but none has given any interesting result. Two fine sarcophagi made of alabaster have, however, been found.

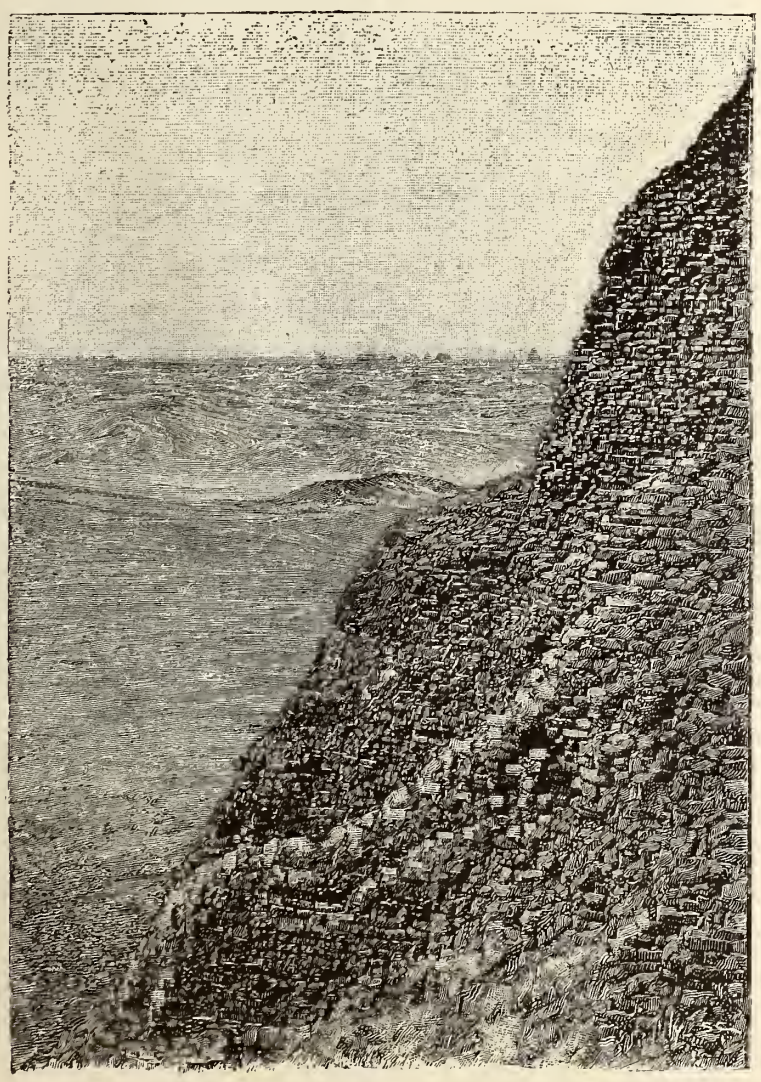
In the meantime, at the other brick pyramid, situated nearly two miles to the south of the first, some important work was being carried on. This pyramid is not nearly in so good a state of preservation as the northern one. Here the work was commenced on the 6th of April, and a series of excavations have been made along the north side, as in the case of the previous pyramid. Some of the discoveries already made will be of great scientific value. The first was the tomb of a king whose name has hitherto been unknown in the compiled lists of Egyptian monarchs. This king's name is Hor Rafou-ab, and his place is at the end of the twelfth dynasty. The tomb also contained a wooden coffin, covered with bands of gold engraved with hieroglyphics, and a statue made of acacia wood, and representing the king. This coffin stood close by and is ornamented similarly to the real coffin. Hieroglyphics cover the gold bands. The statue, which is almost life-size, represents a young man of extraordinary beauty, and is a wonderful example of Egyptian art; in fact, it throws quite a new light on the art of the period.

The next vault had been left intact, and was found just as the mourners left it thousands of years ago, with the funeral offerings surrounding the sarcophagus. A princess had been buried here. Her name was Noub-Hotep, and in the coffin were inclosed jewels of great interest, consisting of necklaces, bracelets, anklets, and other trinkets. A scourge was also in the coffin.

This is how matters stand at Dahchour. The two pyramids have not yet altogether disclosed their secrets, but Mr. De Morgan is quite justified in expecting that success will crown his well directed labors. The value of these latest researches can, of course, hardly be estimated as yet.



MR. MORGAN'S DESCENT.



SOUTH ANGLE OF THE PYRAMID.

## THE LAKE TCHAD CONVENTION BETWEEN FRANCE AND GERMANY.

THE negotiations which have been going on for some time between France and Germany for the determination of the limits of their respective territory in the valley of the Congo and along Lake Tchad were concluded by a convention signed in Berlin on February 4, 1894. The text of the treaty is published in the April number of the *Revue Francaise*. Its articles would probably not interest our readers, but some statements regarding previous transactions and exploration taken from that magazine may be helpful to them in reading the future history of Africa. And there is much likelihood that history may be made rapidly there; for the great powers and the weak ones of Europe are apportioning the continent among themselves in somewhat the same manner that they did the Americas three centuries ago.

The territory concerned in this new treaty lies between the Gulf of Guinea on the southwest and Lake Tchad on the north. To the south and east lies the French Congo territory; to the west, in the valley of the Niger and its branch the Bénoué, are the English possessions. The German territory thus bounded is most singular in shape; it has the form of a pelican, with the head touching Lake Tchad; the beak is toward the east and the neck is formed by the narrow strip between Bifara and Yola. Kameroun and Adamaoua are the names given to this possession.

It seems that in the Anglo-German convention of November 15, 1893, England did a very handsome thing. With that British generosity which is so well known, she gave to Germany some territory which she did not possess, and upon which she made no claim—namely, Adamaoua (except Yola), Baghirmi and Ouadai, with all their possible prolongation toward Oubaughi. It is a large piece, and in their enthusiasm the Germans already saw the flag of the empire floating from the Gulf of Guinea to the basin of the Upper Nile. There was only one obstacle (but it had its weight) to the realization of this beautiful dream, namely, the claims of France, duly established, upon a very important fraction of these lands. England was certainly not ignorant of these claims, but it seems extraordinary that Germany did not appear to be aware of them.

It was not until after the signing of the treaty that Germany, having bought the pelt of the bear, began to ask herself how she could kill the bear to get the pelt. From that time negotiations began with France—negotiations upon which the German delegates, imbued with the spirit of the Anglo-German treaty, entered with considerable claims.

The mission of Nechtritz in Adamaoua produced an analogous effect upon the German negotiators.

This mission was the first which had passed Yola; it had reached there in a boat, in ascending the Niger and the Bénoué. It followed, though very slowly, the course of the Bénoué and of the Mayo-Kebbi, directing itself toward the east. Already they saw it reaching Chari and Baghirmi, thus placing itself between the French establishments of the Saugha River and Lake Tchad. Such were the influences which acted upon the German plenipotentiaries.

If upon the side of Germany there were claims and hopes, upon the French side there were positive facts to present. The *Revue Francaise* (from which this translation is made) has set forth at different times the favorable situation of France gained by its explorers. While De Brazza, methodically ascending the Saugha, effected its final occupation, Mizou, crossing the whole of Adamaoua, from Yola to the Saugha by Ngaoun-

dére, made treaties with the chiefs of the countries which he visited. Then Maistre, going from the Oubaughi to Yola, also treated with all the chiefs of the country, joining again, after Mizou, our possessions in the basin of the Congo with Yola and the Bénoué. . . .

The French delegates were in a good position to negotiate, and the advantage was on their side more than in 1890. However, the basis [of settlement] proposed by Germany at that time finally triumphed, after successive relinquishment of the extreme claims made by both sides. Whatever the German press may say, it is a success for Germany to have obtained not only the territories which were still *res nullius*, but to have seen placed under the sphere of her influence regions which by treaties had been placed under the French protectorate. . . .

In a word, France has completely given up to Germany nearly all the Mizou route situated in Adamaoua and that part of Maistre's route comprised between Lamé and Yola. What does Germany give in exchange for this? Nothing except hopes, and hopes which did not seem likely to be realized soon, though it be granted that the French explorers are considerably in advance of the German explorers in the region south of the Tchad.

One of the great advantages obtained by this treaty seems at first to be the free access to Lake Tchad. Without doubt this has its value; but what profit can Germany derive from it? Will the relations which she can have with Bornou be facilitated thereby? No; for communications will be established with that by land. . . . Access to Tchad is a matter of secondary interest to Germany, while it is of primary importance to France, which could by means of it realize the project of the union of her Algerian, Soudanese and Congo possessions. The essential point in the convention is the assignment of Adamaoua to Germany. Why? Because this region, which is rich, fertile and populated, is also and especially the most habitable and healthiest of all Western Africa, and because it is probably the only one where a European race could settle, become acclimated and grow.

What is Adamaoua? It is a vast plateau situated at an altitude of about 3,250 feet, where a number of groups of mountains lift their summits more than 6,000 feet. It may perhaps be called "the Abyssinia of Western Africa," for it is, like that country, a great reservoir, from which numerous watercourses run to the four points of the compass. The climate is almost temperate, and our agents in the Congo consider it a favorable place for the location of a sanitarium.

From its topographical situation especially Adamaoua will have a great colonial future. Its assignment to Germany is therefore a matter of capital importance, and indeed it is no exaggeration to say that the supremacy given here is the greatest advantage given by the convention. No doubt it is not possible for France to lay claim to all the territory of Adamaoua, the western part of which has been at different times the object of German exploration, but we have a right to claim the eastern part, that visited by Mizou and De Brazza, and to refuse all concession of this part. It is to be regretted that we have not done it.

In the acquisition of territory which the European powers have made in Africa for several years, what they have been obliged to consider first has not been the extent or richness of the territory merely, but the healthfulness and fitness for habitation. Better to own a healthful tract 1,000 kilometers square than one of 10,000 kilometers, however rich it might be, where a European could not become acclimated. . . . .

Let us hope that in the future boundary setting—for there are still many subjects for dispute in Africa—the instructions given to our negotiators will permit them to assert the claims of France in an energetic manner, in order that more ample satisfaction to its interests may be given.

The article by G. Demanche, from which these extracts have been taken, is followed by the translation of an article which appeared in the *Cologne Gazette* soon after the convention was signed. It is an account of the meeting of fifteen men prominent in colonial matters, held at the invitation of the Colonial Department in Berlin. The majority of those present were in favor of the negotiations with France, in view of the impossibility of sending new expeditions, and in view of the fact that the one German expedition of Baron Von Nechtritz cannot counterbalance the numerous results of the French expeditions. The baron's party, it seems, were at that time still in the field with a small body of men, and exploring this almost unknown region as they were, the results were more or less doubtful. However, upon the success of Von Nechtritz's exploration in the direction of Baghirmi, the claim to all Adamaoua and the Upper Bénoué could well be considered safe.

Most of those present at the meeting felt that it was an exceptional time for the imperial government to get some concessions from France without pecuniary returns. Three members of this company, gathered to consider the colonial questions, were in favor of breaking the negotiations with France and of waiting to see the end of Von Nechtritz's exploration, or of sending out a new party into the contested territory. It was not the time, they held, for hasty action, but a moment when they should acquire rights which would ultimately lead to a more advantageous solution of the diplomatic question.

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In connection with this treaty, of so much importance to Germany and France, the very recent Anglo-Belgian treaty is of deep interest. Paris papers, we read, declare that the rights of France and Egypt must not be violated, as they will be if the Belgian Congo is given access to the Upper Nile, and England takes the strip of land between Lakes Albert Edward and Tanganyika.

Mr. Cecil Rhodes, it is believed, will not rest until a strip of land, extending along the east coast from the Cape of Good Hope to the mouth of the Nile is under the British flag, and this new accession, gained by the treaty with Belgium, makes the scheme feasible, if the land along the Upper Nile can be secured.

Mr. Rhodes hopes to put a telegraph line along this coast during the present year, and is said to be seriously considering the building of a railway.

## WHAT IS A COMET'S TAIL?

By A. C. RANYARD.

No bride was ever covered by such a transparent gauzy veil as that which trails behind a comet as it comes to do obeisance to the sun, or as it backs like a courtier out of the solar presence, keeping its train behind it. It has frequently been noticed that the light of small stars is not sensibly dimmed when the tail of a large comet sweeps between the earth and the star; therefore, to compare the matter of comets' tails with a white mist, or a silver fog in space, is too gross a comparison. A few hundred yards of the thinnest fog or mist we are familiar with cuts down very materially the light of objects seen through it, but the light of a star in passing through the tail of a large comet must have traveled through hundreds of thousands of miles of the nebulous material which is streaming away from the nucleus. The thickness of light-absorbing material traversed by a ray of light makes a greater difference than would at first sight be suspected in the amount of light transmitted through a fog or haze, or other absorbing medium, for the light lost increases in geometrical proportion as the thickness of the light-absorbing medium increases in arithmetical proportion; thus, if a haze ten miles thick reduced the light of an object seen through it by one half, a similar haze twenty miles thick would absorb three-quarters of the light that would otherwise be transmitted, for the second ten miles of haze will halve the light that has been transmitted through the first ten miles. Thirty miles of such haze will reduce the light to an eighth, and two hundred miles of such haze will reduce it to about one millionth, for two to the power of twenty is a little more than a million.

On the clearest summer day the brightness of objects at a distance of ten miles on the horizon is reduced to less than one half by the absorption of the intervening atmosphere—a fact that becomes very evident to photographers who attempt to photograph distant objects, and who find that long exposures are necessary to obtain upon their plates any trace of the blue distance which so charms the eye. The tail of a comet must consequently be far more transparent than the earth's atmosphere; indeed, a mass of gas as bulky as the tail of a large comet would—even if it were a thousand times more transparent than air—act as an opaque screen in space, cutting out the light of the stars, and probably even eclipsing the light of the sun itself, if such a cometary tail should pass between the earth and the solar disk.

The light derived from the tail of a comet is generally found to give a bright line spectrum in the neighborhood of the nucleus, and to be more or less polarized at a greater distance from the nucleus. The bright lines seem to point to the presence of incandescent gas, and have frequently been taken to indicate a high temperature in the region about the nucleus; but the spectrum of the aurora which glows in the cold upper strata of our atmosphere is also characterized by narrow gaseous lines, and many comets begin to glow and throw out tails in regions of the solar system where they can derive but little heat from the warming effect of the sun's rays.

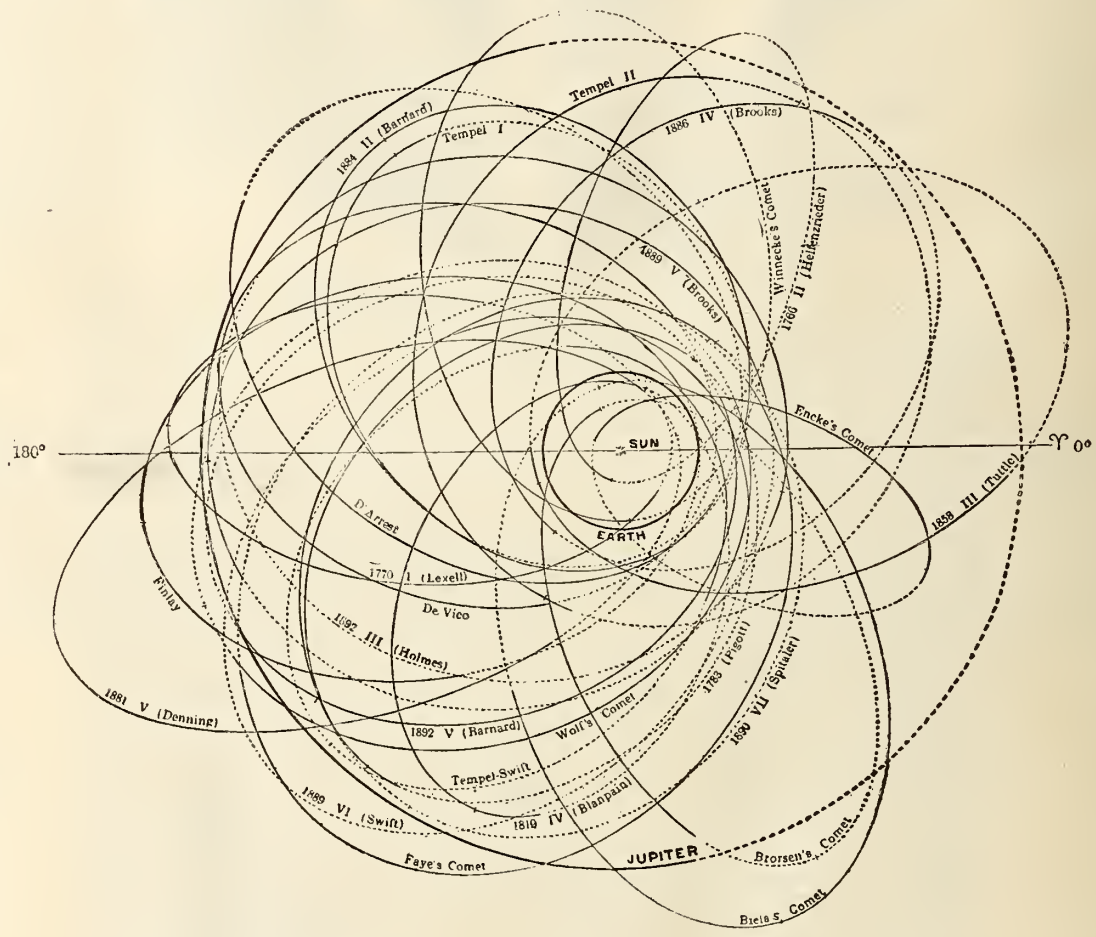
Thus according to Mr. Marth, comet Brooks, at the time of the photograph reproduced in our plate (October 21), was at a distance 1·02 times the earth's mean distance from the sun—that is, it was at a little greater distance from the sun than the earth ever is.* We may therefore compare the temperature of the comet as derived from the sun's rays, at the time that its photograph was taken by Prof Barnard, with the temperature of the moon, and it was shown in the article in the April number that the temperature of the moon's equatorial regions during the lunar day probably does not exceed the temperature of melting ice. Consequently, if the ebullition which was evidently going on in the nucleus of Brooks' comet at the time the photograph was taken was due to the rapid driving into vapor of matter by the sun's heat, the material that was being vaporized must have had a very low melting point, such as is possessed by carbonic acid or substances which freeze at a still lower temperature, such as hydrogen, nitrogen, and other forms of matter which in terrestrial laboratories we are, under ordinary circumstances, only familiar with in their gaseous state.

The way in which comets' tails, as a general rule, slowly develop in size as they approach the sun, and again diminish as they recede from him, would seem to point to the conclusion that the growth of comets' tails is principally due to the intensity of the sun's heat, or to some other cause which varies with the distance of the comet from the sun. But the rapid variations in form and brightness which many comets have exhibited seem to show that the evolution of gas from the nucleus, and the repulsion of matter in the tail, is influenced or in some way partly controlled by some more irregularly varying conditions, such as collisions with meteors, or dust in space, or the passage of the cometary nucleus through a mass of gas. The rapid variations in form and brightness which a comet sometimes undergoes are well illustrated by the four photographs of Swift's comet, taken by Dr. Max Wolf, which are reproduced in our second plate. A still more striking instance of a rapid increase of brightness was afforded by Holmes' comet, which, at more than double the earth's distance from the sun, seems to have suddenly brightened up.

Before attempting to speculate on the causes of these irregular variations in brightness, it may be well to give an account of the phenomena which are usually observable. A comet when it is first seen as it approaches the sun, and also when last seen as it recedes from the sun, generally appears as a small roundish patch of faintly luminous nebulosity, sometimes with a brighter patch or stellar point near the center. As the comet brightens on approaching the sun it generally begins to emit jets or streamers, or to form more or less symmetrical envelopes on the side next the sun, and develops a tail on the side remote from the sun. In the great comet of 1858, usually known as Donati's comet, the action was most symmetrical, one envelope after another rising from the nucleus and expanding, as if the material forming the envelopes was repelled by the nucleus, and was also repelled by the sun, till it was ultimately driven away within a hyperbolic envelope or stratum which formed about the nucleus.

The tail in this and other comets seemed to be composed of hollow cones slightly bent backward in the plane of the orbit. The backward curvature is easily explained, because particles repelled from the comet's head would still retain their original orbital motion, and would fall behind the line drawn from the sun through the comet's nucleus, as they were driven into a larger and larger orbit. The amount of backward curvature of the tail evidently depends on the velocity with which the particles are driven away from the sun, and we find in this and other comets multiple tails, indicating that the different branches of the tail are composed of different materials which are repelled from the sun with different velocities.

But in Dr. Max Wolf's photographs of Swift's comet we find no such hyperbolic strata enveloping the nucleus; the matter seems to be driven directly away from the nucleus, and not in the first instance to be driven into an envelope about the nucleus prior to its being driven away from the sun. Perhaps the discre-




Jupiter's Family of Comets.

The dotted portions represent the parts of the orbits below, *i. e.*, to the south of the ecliptic.

* During our summer in the northern hemisphere the earth attains a distance of 1·01677 times its mean distance from the sun.

pancy may be explained by the repulsion from the nucleus being comparatively feeble, so that the envelopes about the nucleus are small and are hidden by the nebulosity about the head of the comet. In Swift's comet, the streams of matter radiating from the nucleus all seem to be bounded by straight lines, though they radiate in slightly different directions from the nucleus. In the photograph of Brooks' comet there are similar straight rays radiating from the nucleus in addition to the curious curved and branching structure which forms the brightest part of the tail. If we look for an analogy with the more regular struetures of Donati's comet, it would seem that the great branching structure corresponds to one of the jets which issued from the head of Donati's comet, while the small straight rays in Brooks' comet correspond to the streams which formed the bulk of the tail in Donati's comet.

The spectral lines observed in the light from the heads of different comets indicate that the chemical constitution of one comet differs from another, and it is perhaps to be expected that the general appearance of comets, and the phenomena they exhibit, should also vary according to the materials of which they are composed.

The light from the remoter parts of the tail is usually more or less completely polarized according to the position of the comet with respect to the sun and earth, in a manner which indicates that the matter of the comet's tail disperses the sun's light as fine dust would do. It seems, therefore, probable that the remoter parts of the tail of a comet consist of very minute particles, whose average diameter is small compared with the wave length of light, and that the material of which it is composed has been precipitated from the gaseous matter driven off from the nucleus.

In 1872 the medal of the Astronomical Society was given to Prof. Schiaparelli, of Milan, for showing that there was an intimate connection between certain meteor streams and comets. He showed that the August meteors revolve in an orbit which is, as near as can be determined, identical with the orbit of comet II., 1862, usually known as Tuttle's comet, and that the November meteors move in an orbit which is practically identical with the orbit of comet I., 1866, known as Tempel's comet. A few years later it was shown that the Andromid meteors are revolving in a track which is practically identical with the orbit of Biela's comet, and that the April meteors are also associated with a cometary orbit. In view of this evidence, it seems highly probable that the nebulous matter which renders comets visible is evaporated from meteor swarms as they approach the sun, and that the matter thus separated from the meteors is repelled by the sun, never to be regathered by the meteor swarm. It would follow that the meteor swarms which are associated with comets are wasting away and losing a portion of their substance every time that they approach the sun. Possibly some of the particles driven away may fall upon the planets and go to augment their atmospheres, taking the place of carbon, oxygen, and other elements which have been absorbed or added to the solid substance of the planet by the processes of life, oxidation, and other chemical changes continually going on; and it would seem to follow that comet-producing meteor swarms cannot last for geologic ages, and that those which are now associated with comets must have been introduced into the solar system within a comparatively recent period—a conclusion which is opposed to Mr. Proctor's and Sir Robert Ball's ejection theory, which assumes that comets and meteors had their origin within the solar system, and were ejected from the sun and the larger planets at an early period when these bodies were in a sun-like state.

The accompanying diagram has been copied from a drawing made by Mr. A. G. Sivaslian, of Northfield, Minn. It represents Jupiter's family of comets, and was originally published in an interesting article by Prof. W. W. Payne in the October number of his *Popular Astronomy.*

It will be noticed that nearly all the farthest points of these orbits (the aphelia) are one side of Jupiter's orbit, and that the places where the dotted portions of the orbits join the continuous ones are in nearly every case close to the orbit of Jupiter. The dotted portions of the orbits are below the ecliptic, while the continuous portions are to the north, so that one of the nodes of the comet's orbit is in every case near to the orbit of Jupiter. If Jupiter were at that part of his orbit at the time when the comet was passing its node, the two bodies would really be near to each other, and Jupiter, by his great mass, would have a very marked influence in changing the orbit of the comet. It seems, therefore, probable that all these comets have at some time been considerably perturbed by Jupiter.

The sun and the whole solar system is moving through space toward a point in the constellation Hercules, having a right ascension of about 269° and a north declination of about 35°. The bottom of the plate corresponds to right ascension 270°, consequently, a vertical line on the page approximately corresponds to the direction in which the solar system is moving—probably at a rate of some ten miles a second.* Jupiter is moving in his orbit with a mean velocity of a little more than eight miles a second, in a direction contrary to the hands of a watch when looked at from above the ecliptic, as in the diagram; consequently, when Jupiter is in the part of his orbit which lies on the left hand side of the diagram he is moving very rapidly through space, with a maximum velocity of about eighteen miles a second, while in the part of his orbit which corresponds to the right hand side of the page he is moving in a direction about the sun nearly contrary to the sun's motion in space, and when going slowest he is only moving through space with a velocity of about two miles a second. The distribution of the aphelia of the cometary orbits shows that Jupiter has caught many more comets when moving rapidly through space than when he is moving slowly. But this is only what might be expected if the comets were all originally caught from outside the solar system, and it forms an interesting additional piece of evidence tending to prove that the sun is actually moving in space, and that the comets of Jupiter's family were not originally members of the solar system.

* This is the velocity determined by Prof. Vogel from his observations of the motion of stars in the line of sight. It seems to be the most trustworthy determination of the velocity of the sun's motion in space that we at present have.

A similar piece of evidence tends to show that the meteors we encounter were not originally members of the solar system. It has long been known that the earth encounters a larger average number of meteors in the autumn half of the year than in the spring half, from midwinter to midsummer; that is, when the earth is moving most rapidly through space it encounters fewest meteors. Exactly the contrary of this would be the case if the majority of meteors were sporadic—that is, if they came from outside space. But with meteor streams captured by the larger planets in the way in which Jupiter has annexed his comet family, we should expect to find the earth most involved among the perihelia of such elliptic streams on the opposite side of its orbit from that on which the larger planets are most successful in capturing such streams. The observed facts can, therefore, be best explained by supposing that the majority of meteors are now moving in closed orbits, which are arranged in a manner that shows that meteors as well as comets were originally captured from outside space. —*Knowledge.*

## DENDROBIUM NOBILE VAR. SCHRODERIANUM.

SINCE the Chinese drawing of D. nobile in the library of the Royal Horticultural Society drew attention to this now well known species about three-quarters of a century has elapsed. The first live specimen came home through China and flowered in Messrs. Loddiges' nursery at Hackney, in 1837. Since that time enormous quantities have been imported, and these have been collected over a wide area, while so marked is the habit which prevails in some localities that experienced growers are able to tell whence the plants came from their appearance. Few orchids are better known than D. nobile, and few have shown a greater tendency to vary in form and color. Between D. n. nobilius on the one hand and D. n. albiflorum on the other there is a wonderful diversity of color, and one of the finest of these intermediate variations is D. n. Schroderianum, of which we give a figure. The plant from which the drawing was made is in the celebrated collection at Egham, belonging to Baron Schroder, and so ably managed by Mr. Ballantine. In habit this

DENDROBIUM NOBILE SCHRODERIANUM.

variety resembles a sturdy D. nobile and produces its flowers in twos and threes, from almost every node of the ripened growth. The sepals and petals are large and broad, pure white, with in one or two instances a suspicion of purple at the apex of a segment; the lip is also large, having a deep marone purple disk which approaches black in intensity, this is bordered with creamy yellow which shades to pure white before it reaches the margin. In size of flower this variety has few equals, and is only excelled in this respect by well grown blooms of D. n. nobilius. D. n. Schroderianum is most distinct and beautiful, and readily obtained a first-class certificate when exhibited recently at the Drill Hall, Westminster.—*The Gardeners' Magazine.*

## THE SASSAFRAS.

THE sassafras is one of the most interesting trees of the forests of eastern North America. The last survivor of a race which at an earlier period of the earth's history was common to the two hemispheres, it is the only tree in a large and important family of plants which has been able to maintain itself in a region of severe winter cold. The structure of the flowers, like those of other plants of the laurel family, to which the sassafras belongs, is curious and not easily explained with reference to special adaptations to special ends; while the extraordinary virtues which were credited to this tree for nearly two centuries after its discovery have thrown a certain glamor of romance about its history.

Toward the middle of the sixteenth century the French in Florida heard from the Indians wonderful accounts of the curative properties of a tree which they called pavame, and which, for no obvious reason, the Europeans called sassafras. The tree and its virtues were first described by the Spanish physician, Nicholas Monardes, in his "Natural History of the New World," published in Seville in 1569. The reputation of the roots and wood of the sassafras as a sovereign cure for most human maladies soon spread through Europe, and extraordinary efforts were made to obtain them. To collect sassafras was one of the objects of the English expedition which landed on the Elizabeth Islands, at the mouth of Buzzard's Bay, in Massachusetts, in 1602; and eight years later sassafras is mentioned among the articles to be sent home in the instructions of the English government to the officers of the young colony in Virginia.

For nearly two centuries the reputation of sassafras was maintained, and many medical treatises have extolled its virtues, although now it is generally recognized as simply a mild aromatic stimulant. Recently the thick pith of the young branches has been found to yield a mucilage useful to oculists, as it can be combined with alcohol and subacetate of lead without causing their precipitation. The oil of sassafras, obtained from the wood and roots by distillation, is used to perfume soap and other articles, although synthetical oils now replace it for most ordinary purposes; and perhaps, after all, the most useful product of the sassafras tree is the yellow powder prepared from the leaves by the Choctaw Indians of Louisiana, used to give peculiar flavor and consistency to gumbo file, one of the best products of the Creole kitchen. The sassafras is one of the common trees of our eastern forests, and is found from the shores of Massachusetts Bay to central Florida, with a western range which extends to beyond the Mississippi, reaching its greatest size in southern Arkansas and the Indian Territory, where individuals, fully eighty feet tall, with trunks six or seven feet in diameter, are occasionally seen. Usually, however, it attains more modest proportions, and trees exceeding a height of forty or fifty feet are not common; and in the North the sassafras is usually even smaller, and is often shrubby in its manner of growth.

The bark on the trunk of a fully grown tree is often an inch and one-half thick; it is dark red brown and deeply divided into broad ridges, which separate on the surface into thick appressed scales. The branches are short and stout and often somewhat contorted; placed nearly at right angles with the stem, they form a narrow, rather flat-topped picturesque head. The beauty of the sassafras is increased by the lustrous green color of the young branches, which they do not lose until the end of two or three years, when the bark gradually turns rather light red brown and begins to display the shallow fissures which mark the older branches and young trunks. The winter buds are covered with loosely imbricated scales; of these the three outer enlarge but slightly when the branch begins to grow, and soon fall off; they immediately surround four or five scales which begin to grow with the opening of the bud, and at maturity are obovate, rounded at the apex, concave, coated with silky pubescence, light yellow and much reflexed, forming, when expanded, a sort of involucre. In the axils of these scales the flower clusters appear, and inside and above them are two erect lanceolate scales infolding the leaves and falling when these begin to unfold. The bright color of the involucre, which gradually turns red in fading, makes the sassafras conspicuous and attractive in early spring.

The flowers appear almost immediately after the opening of the bud, and are borne in slender drooping racemes two or three inches long, the males and females usually on separate trees, although perfect flowers may sometimes be found. The perianth or calyx is about an eighth of an inch across when fully opened, pale yellow green, and divided nearly to the base into six obovate, narrow, concave lobes in two ranks, those of the inner rank being a little larger than the others; after the flower opens, the lobes spread and finally become much reflexed. There is no corolla; and in the sterile flower there are nine stamens arranged in three ranks and inserted on the short, slightly thickened calyx tube; the filaments are flattened, elongated, slightly enlarged toward the apex, incurved and light yellow, those of the inner rank being furnished near the base with two conspicuous orange colored stalked glands; the anthers are orange color, fixed on the summit of the filaments, and four-celled, with cells superposed in pairs, facing the center of the flower and opening from below upward by persistent lids. In the pistillate flower the stamens are reduced to minute, flattened, ovate, pointed slightly, two lobed, orange colored, stalked staminodia, or are rarely perfectly developed. The ovary, of which there is no trace in the staminate flower, is one celled, light green and glabrous, with a single ovule and a simple elongated style crowned with an oblique, slightly lobed, stigma. The leaves, which begin to unfold as the flowers open, are involute in the bud, the lowest infolding all those above it. They are ovate or obovate, entire, or often one to three lobed at the apex, the lobes being broadly ovate, acute and divided by deep broad sinuses; at the base they are narrowed into long slender petioles. When the leaves first unfold they are light yellow green, and clothed on the lower surface with delicate, lustrous, white hairs, and at maturity they are dark green on the upper surface, and pale and glabrous or pubescent

on the lower surface, three to four inches long and two to three inches wide, the two forms being produced together on the same branch. The leaves fall in the autumn after assuming delicate shades of yellow, orange, or orange and red. The fruit is a dark blue, thin-fleshed, oblong, aromatic berry, surrounded at the base by the enlarged and thickened, bright scarlet calyx tube, and raised on a stalk which has lengthened during the summer, turned scarlet and grown thick above the middle. The fruit of the sassafras is not produced very abundantly, although in some years it may be found in great quantities; and its aromatic flavor is so attractive to birds that they usually devour it as soon as it begins to color. The wood, which is orange color, with thin, pale sap wood, is very durable when placed in contact with the soil. It is coarse grained, however, and not much used, except in fencing.

The sassafras is a common native tree, and so is usually neglected by those who plant parks and gardens in the United States. No hardy tree, however, is more beautiful at every season of the year or better worth cultivating in the Northern States. Its fragrant leaves and branches, its delicate inflorescence and showy fruit, its immunity from the disfiguring attacks of insects and disease, and the peculiar charm of the autumn colors of its foliage make it a beautiful object; and its relationship to the camphor and other valuable trees of the tropics make it interesting.

The sassafras is easily raised from seed, which should be planted as soon as they are ripe, when they will germinate early in the following spring, or by transplanting the suckers, which it often produces in great abundance. The thick, fleshy roots, covered with thick, fragrant, light yellow bark, which penetrate deep into the soil, make the sassafras a difficult tree to transplant, and only young plants should be selected for this purpose.—*Garden and Forest.*

## WINTHROP GARDENS.

### A WOMAN FARMER.

A REPRESENTATIVE of the *Ploughman* recently visited a farm where science applied to soil is the rule of action, and where skill and long experience under the directing eye of a real business woman are producing great results.

Winthrop Gardens, conducted by Miss Mary E. Cutler, the well-known and successful woman farmer of Massachusetts, are situated at Holliston, about twenty-five miles from Boston, near Lake Winthrop, a pretty sheet of water from which the gardens were named. The location is quite favorable, being within trading reach of at least 30,000 people, besides having the Boston market and several canneries as a resort for surplus products. The soil of the farm is good, but naturally not better than thousands of other farms in the State. Business methods and modern ideas, rather than natural advantages, explain the success of Miss Cutler's enterprise.

Miss Cutler believes that farming pays. So she says: "It is a good business for one who is young and willing to work. When you hear of a farm running down, you may be sure something is wrong with the owner. I see no reason why a lady cannot conduct a farm as well as anybody. I never do any field work, I merely direct. I do not even board my workmen, any more than I can help, but prefer to hire by the day or year. The business outdoors requires constant attention."

#### POINTS ON PEACHES.

"What are your specialties, Miss Cutler?"

"At least two-thirds of our attention is devoted to the production of vegetables and fruit, which are sold from our teams direct to the consumers, while the surplus goes to the canneries. We have also a large and growing trade in nursery stock, plants, cut flowers, and the like. There are six acres of nursery stock and 9,000 square feet of glass. For live stock we have three horses, eight cows and fifty hens. The milk is sent to Boston, but the eggs are mostly used at home. Among so many branches of the business, some can hardly fail to pay, whatever the season, so that the year's business evens up with a good profit. But our specialties are fruit and vegetables for our market team. One of our most important branches is the peach crop, and it pays."

"Then, according to your experience, peaches can be made a success as far north as Massachusetts?"

"Oh, yes. We have not had a failure of the peach crop for seven years. Two years ago we sold 700 baskets, and last year we sold 450 baskets. We have now 1,400 bearing trees and appearances promise a fair crop for the coming season. The trees are set fifteen feet apart, with standard apple trees in every third row. When the peaches die out, the apples will be in profitable bearing."

"What is your plan of cultivation?"

"We set out trees one year from bud. For this locality, the Early Crawford and the Crosby have proved most satisfactory. We also grow the Late Crawford, Stump the World, Elberta, Mountain Rose and others. The soil of the orchard is plowed in the spring and kept stirred with a cultivator until August. Cultivation should cease by August, or a late growth will be induced, and the trees be winter killed. We fertilized the orchard last season with 1,000 pounds of ground bone and 500 pounds of muriate of potash. In May we trim out the trees and head in the tops four to six inches. This operation prevents the trees from growing out of easy reach and increases fruitfulness. Also about the last of May, or as soon as the fruit buds can be seen, we pinch off the fruit buds except four or five on each branch. The fruit that remains will be much larger, and the trees will escape injury from overbearing.

"Harvesting the peaches is an important matter. One experienced man does it all. The fruit is handled as carefully as eggs. A bruised peach overnight is a rotten peach next day. It is also a nice point to tell the ripeness of the peach, even when hard, by its color. A practiced eye can tell by the deepened red and golden hue that a peach will be mellow next day.

"In marketing this crop, it is the sorting that sells our peaches. We make first and second grades, and our customers know that the quality is always uniform. The fruit is easily sold at good prices. Peach raising has been attracting more notice of late in this region. It seems as if all the farmers are getting crazy to set out peach orchards."

#### PEARS.

"Among other tree fruits we have an acre and a half of pears; Bartlett, Sheldon, Lawrence and Keiffer. The Keiffer is a success, and sells well in spite of its quincy flavor. It ripens about Christmas time, when the demand is good. There are also several acres of apples, early and late. Our grape vineyard is quite successful. Concord grapes are most productive, but the Delaware is more profitable, selling here for ten cents a pound when the Concord and Worden bring only three cents. Other profitable grapes are the Green Mountain, Pocklington, Diana, Moore's Early and Niagara. The vines are trained on a wooden trellis, with a single rail, about four or five feet from the ground."

#### SMALL FRUITS.

"Do you raise small fruits?"

"Yes; mostly strawberries, of which we have a field of one acre. For varieties, I would recommend Bubach for early, Belmont for medium, and Parker Earle for late. We set the plants one foot apart in rows four feet distant. In the berry field, as in other parts of the farm, we aim to make the horses do most of the work. Our currant patch is also quite a success. Fay's, Cherry and Versailles prove almost equal in merit. There is no demand for white currants. The plants set at a distance of two feet in rows four feet apart. The cultivator is run between the rows and a pronged potato digger is used to clean out between the plants. For both strawberries and currants the men prefer a potato digger rather than a common hoe. Slug shot is successfully used for the currant worms."

#### ASPARAGUS—HORSE POWER.

"I see you have a large field of asparagus, Miss Cutler. Do you not find it a hard crop to care for?"

"Not at all. Everything is done by horse power. When the field becomes weedy, we simply cut off the asparagus shoots clean, and run the harrow or cultivator right over the field, plants and all. The weeds are killed and the asparagus is not injured. We keep up the process through the season. Manure is applied in the fall. The rows are four feet apart and the plant only six inches apart in the rows. We prefer the Palmetto variety, which is certainly much larger than Conover's Colossal, and is fully as early. We set our two-year-old plants of asparagus, just the same as any other plants, without any trenching or other extra work. The crowns, however, are sunk a few inches below the surface. We have used a cheap grade of salt to keep down the weeds, and find the plan quite successful. We have never been able to produce enough asparagus to meet the local demand. The soil is kept very rich.

#### TOMATOES.

"Tomatoes have also proved a success. Most of them are sold from the cart, but the cannery at Franklin will take the surplus at thirty-three cents a bushel. The plants are raised in hotbeds and are set out about May 20. The best kinds are Early Dwarf, Champion, President Cleveland, Boston Market and Paragon. The horse cultivator subdues the weeds and the cut worms are killed with an infusion made from tobacco leaves. We raise enough tobacco for this purpose and to fumigate the greenhouse.

#### SWEET CORN.

"This year three acres of sweet corn will be grown. It should net $60 an acre at the cannery and furnish some valuable fodder. I intend to build a silo to preserve the fodder. Nearby is a field of two acres, which will be planted to cucumbers. A part of these will be made into pickles on the farm and sold by the barrel at the local markets. There will also be three acres of potatoes, two acres of spring rye, one acre of squashes, and one-half acre of peppers and celery, besides smaller beds of the other vegetables. Our greenhouse and hotbeds, with their 9,000 square feet of glass, require also a great deal of care."

#### BUSINESS METHODS.

"How do you provide for the labor?"

"Six men are kept busy during the growing season, and two men the year round. The foreman, Mr. Pakin, has been on the place seventeen years. Another man has been employed twelve years, and another four years. Boys are hired to do weeding at from fifty to seventy-five cents a day. It is easy to get berry pickers from the town."

"In marketing you do not rely much on Boston commission men?"

"No; it does not pay me to ship to Boston. The commission men return just what they please. Early peas and apples often sell well in Boston, but for most crops the prices received are not profitable."

#### MISS CUTLER'S CAREER.

Miss Cutler became sole manager of Winthrop Gardens after her father's death, ten years ago, since which time the business has constantly increased, until it now amounts to a total of three or four thousand dollars annually. The death of her father was very sudden, and no plans had been decided upon for the season's work. Miss Cutler's friends all advised her against attempting to carry on the farm. She might be able to go on for a year or so, they said, but it was absurd to suppose that a woman could make a business success of farming. However, she determined to leave the school where she had been teaching and to attempt what seemed to her the more pleasant and profitable occupation of farming. Proceeding cautiously, only one-half the usual business was planned out for the first season, but each year since the industry has been increased and new ideas introduced. Besides personal supervision of the farm work, Miss Cutler has devoted some attention to music and art and to writing for agricultural papers. She has always been prominent in the local grange, having been lecturer for six years and also secretary. But her chief pride lies in the snug and profitable business that has grown up under her care, and her just claim is that her little estate of sixty-eight acres, nineteen in tillage, is the most productive farm in the town.—*Massachusetts Ploughman.*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## BOMBS AND INFERNAL MACHINES.

THE word "bomb" must not be taken here in the restricted acceptation of a hollow projectile thrown by a piece of ordnance called a "mortar." It is an onomatopœia, implying the general sense of a receptacle filled with dangerous substances and capable of bursting with more or less noise under the action of a determinate internal or external movement. When solid substances of various kinds and sizes, designed to act after the manner of projectiles, are mingled with the charge, the bomb takes the name of "infernal machine." This latter is merely a variant of the bomb properly so called.

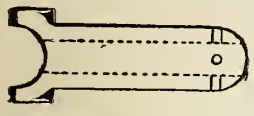

FIG. 1.—Fusee of a Hand Grenade of the Seventeenth Century.

Apparatus of this kind have been used at all periods, even before the epoch of the invention of detonating powder. For the envelopes of their primitive apparatus, the ancients ordinarily used pottery (*vasa fictilia*), oblong two-handled vessels called *amphoræ* earthen jugs (*fictiles lagenas*), pots (*ollas*) and every kind of earthen or glass vessel that satisfied the sole condition of being essentially fragile. We shall presently tell why such a condition was necessary.

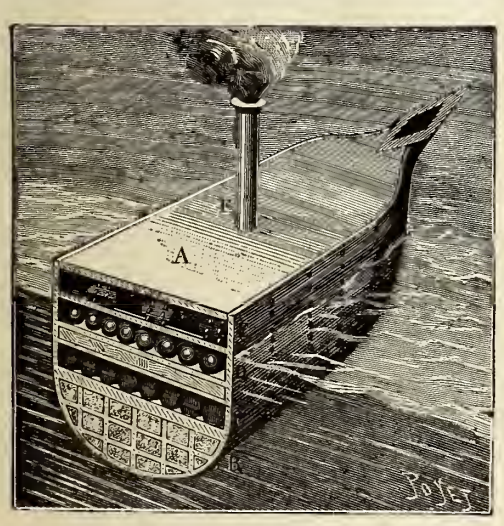


FIG. 2.—ST. MALO INFERNAL MACHINE.

A, elevation and section; B, bottom of hull filled with sand; C, main deck filled with twenty thousand pounds of powder with a foot of masonry above; D, lower deck with six hundred bombs and fire balls and two feet of masonry above; E, upper deck with fifty iron-hooped barrels filled with all sorts of explosive devices; F, chimney for setting fire to the powder and primers.

In the time of the Punic wars, the charge consisted of inflammable substances, such as pitch and resin or pitch and incandescent carbon. Eventually this charge was formed of Greek fire.

After the manner of Grecian and Roman antiquity, the middle ages likewise inclosed all sorts of things except incandescent substances in terra cotta or glass globes, but which were capable, nevertheless, of causing death through wounds, punctures, asphyxia, suffocation, or poisoning, or of merely exerting an irresistible repulsive action. Into them were put venomous serpents, juices of poisonous plants, metallic salts giving off mephitic vapors, animal substances in the process of putrefaction, and, as Siemienowicz says, an infinite number of other stinking and filthy materials. The Greeks of Byzantium introduced human excrement (*κόπρον ἀνθρωπείαν*) into them, and the natives of Liege, of the fifteenth century, did the same as the Greeks (*stercoribus injectis*). It is from this that come certain words of the vigorous military language—expressions *sui generis* that can scarcely be written in French or even in Latin.

As for the play of the deleterious or repugnant burning missile, that is very easy to understand.

The bomb was thrown either by hand or by means of a ballistic machine. At the instant of its fall, the fragile envelope, glass or terra cotta, broke and the charge was thus set at liberty. The fact of the discovery of gunpowder was rather of a nature to cause the fall into desuetude of these mediocre means of action, in which, however, must be recognized the merit of having put the pyrotechnic engineers in the way of the preparation of hollow projectiles containing an explosive discharge.

The first bomb that came from the laboratories of these engineers was the stink pot (*pot-au-feu*), which made its appearance as long ago as the beginning of the sixteenth century. The "pot" of this epoch consisted of a cylinder of glass or terra cotta filled with quicklime and granulated powder. An infernal machine was sometimes made of it by mingling a few pieces of iron with the powder. The firing was effected by means of a sulphured slow match.

The grenade, the invention of which also dates back to the first years of the reign of Francis I., was thus called by reason of its resemblance to the fruit of this name (*granatum*), called also Punic apple (*malum punicum*). It made its entrance upon the stage officially at the siege of Rouen, in 1562.

Now, remark that toward the end of the sixteenth century crime had already made its *debut* in the art of imitating the processes of the military art. In 1587 we find a Norman dispatching to a Parisian who had gravely offended him a box containing three tubes or gun barrels loaded for bursting, and so arranged as to go off at the precise moment of the opening of the box. The combination succeeded, the Parisian was killed and the Norman was condemned to the punishment of the wheel.

The seventeenth century witnessed the production of a host of pyrotechnic inventions, in the front rank of which it is well to place those of Jean Appier, called Hanzelet, "master of fireworks" of His Highness Charles IV., Duke of Lorraine. This emerited pyrotechnist recommended the use of the fire cask, the "most furious fire-vomiting machine in an assault," "partridges" and "rabbits" —"badly digesting game for those who taste it"— and a number of various other apparatus, "which, being properly contrived, are capable of cutting out disagreeable work for the enemy." Hanzelet also extolled the excellence of his firework box, an infernal machine mounted upon wheels, and that exploded as soon as it was touched. The firing was effected by means of a play of two "wheels that unclick" at the least motion of a strange hand. But observe a lofty spirit pervading western Europe. It was a question of doing things on a large scale. The effects produced by some little infernal machine no longer sufficed. What was necessary was a style of monster bomb capable of ruining important works of man's hand at one fell stroke.

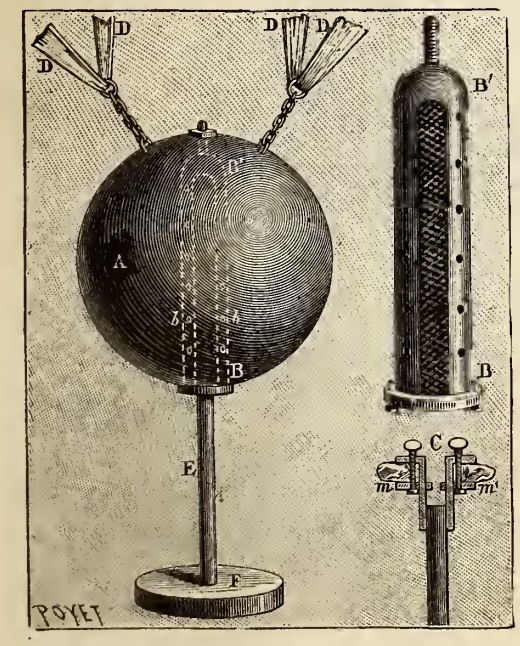


FIG. 3.—BLIND GRENADE.

A, charging aperture; B B, internal cylinder; C, barrels to fit into the latter; *m m*, flints; D D D D, slings for throwing the grenade; E, rod entering the cylinder, B; F, foot; *b b*, apertures to allow of the passage of the sparks produced by the friction of the flints.

Federico Giannibelli endeavored to destroy a bridge thrown over the Escaut, and, to this effect, constructed four large boats, each of which took aboard 7,700 pounds of powder, and in this charge he buried bullets, hooks, nails, and scrap iron.

In 1605, the mine prepared by the confederates of the powder conspiracy for blowing up Westminster consisted of thirty-six barrels, probably of about two hundred pounds each. According to the example given by such precedents, Louis XIV., in 1688, conceived the idea of ruining the port and city of Algiers through the bursting of a huge bomb filled with from seven to eight thousand pounds of powder.

It was natural that the Anglo-Dutch, implacable enemies of France, should, in their turn, imitate the great king, and this they did for more than a century. The infernal machine that they dispatched in 1693 against the port of St. Malo was a 300 ton bomb vessel, 34 ft. in length and 18 ft. in height, and drawing 9 ft. of water (Fig. 2). The main deck was filled with 20,000 pounds of powder, placed under solid masonry; the lower deck contained 600 bombs and fire balls, likewise inclosed in masonry; and the upper deck 50 barrels of firework embedded in a sort of concrete. Finally, the orlop was covered with 340 fire balls, grenades, bullets, chains, bits of metal, gun barrels with bursting charges, scrap iron, nails, etc. The interstices were filled in with combustible substances, and tarred canvas covered the whole. This huge floating bomb was towed leeward to the city. It had nearly reached the sea front of the enciente when a shifting breeze drove it off toward a rock, upon which it was observed to founder. The engineer who was steering it, seeing that it was sinking, hastened to set fire to it, and, of course, to desert it.

Although the explosion was effected far from the objective point, it produced a disastrous effect. A portion of the city was destroyed, and all the houses were shaken. The capstan of the galiot, weighing 2,000 pounds, was thrown over the ramparts and crushed a house upon which it fell. A part of the float did not blow up, and this fragment permitted of restoring the construction represented in Fig. 2.

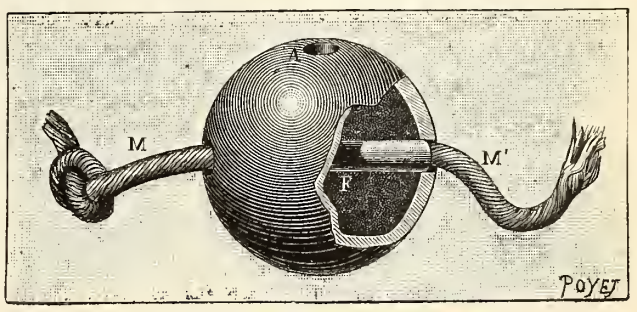


FIG. 4.—STATIONARY BOMB.

A, charging aperture; *m m'*, slow match; F, perforated tube.

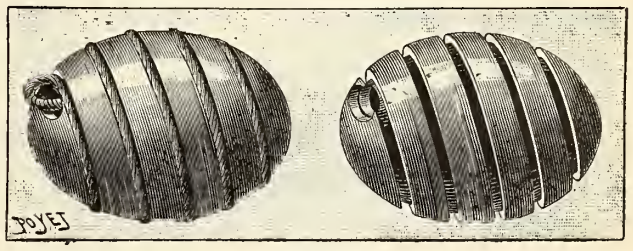


FIG. 5.—HEIMLICH OR LEG FEUER.

In spite of the excellence of the infernal machines of various models, the granade was to continue to be justly appreciated by military men. The value of this explosive being well recognized, Louis XIV. organized the "Grenadiers," at first to the number of four in the regiment of the "Fusiliers of the King." In 1672, this regiment comprised two battalions, each of twelve companies of fusiliers and one company of grenadiers. The men of the latter carried crosswise a *grenadière*, that is to say, a pouch containing their hand projectiles. A grenade of this epoch consisted of a small globe of bronze or iron filled with "pyric" (*pulvere pyrio*) or gunpowder or some other pyrotechnical composition. To its orifice was fitted a tube (fistula), which was filled with a composition that was slow-burning, lest the globe should burst in the hands of those who had to throw it. Fig. 1 shows a section of the fusee of a hand grenade of the middle of the seventeenth century. The pyrotechnists of the time called those grenades *blind* that had no "eye" to give passage to a slow match, and that were, consequently, thrown

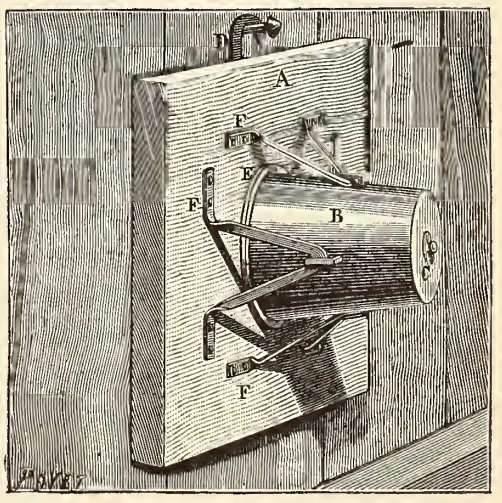


FIG. 6.—BRONZE PETARD.

A, plank to be applied against a door; B, petard attached to the latter; C, vent of the petard; D, hook for attaching the apparatus to a door; E, felt; F F F, petard braces.

without any match being lighted. "As soon as they touch the earth," says Siemienowicz, "or meet with any hard and fixed object, they promptly take fire and produce effects like other grenades." They were what we should to-day call explosive apparatus with percussion fuses.

Fig. 3 represents one of the types of "blind grenades" of this epoch. In addition to its charging aperture, it has two diametrically opposite orifices. The top one was tapped so as to receive the screw of an iron plate cylinder provided with apertures, and "all chased on the inside; that is to say, as rough and as sharp as a file." The author means to speak of a rugosity into which entered a system of two small barrels mounted upon a rod that was introduced with

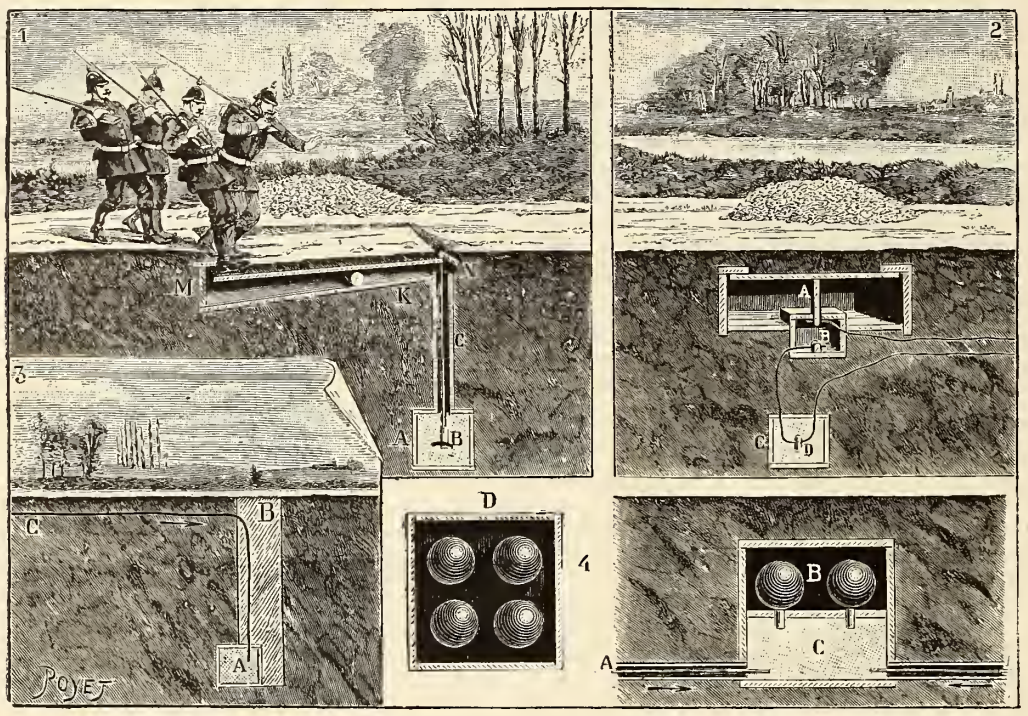


Fig. 7.—FOUGADES OR DRY TORPEDOES.

1. Automatically exploding fougade. 2. Electric automatic torpedo. 3. Ordinary fougade: A, powder box; B, well; A B C, exploding conductor. 4. Bomb fougade: B C, box with two compartments for bombs and powder; D, plan of the box.

slight friction through the lower orifice. This rod itself terminated beneath in a foot, upon which, by reason of preponderance, the thrown bomb always fell. What then happened? The author will tell us: "As soon as the grenade falls upon this wide and flat foot, the barrels inclosed in the cylinder are forced, through the weight of the said grenade, to ascend, and, consequently, the flints, rubbing harshly against the internal furrows of the cylinder, never fail, through this violent collision, to strike fire, which, immediately insinuating itself through the apertures in the cylinder, communicates with the powder inclosed in the grenade. By this means, it will cause it to produce the same effect as if it had been prepared in another manner."

Let us rapidly review a few other arrangements of the engineers of this time, which was so fecund in pyrotechnical inventions.

The stationary bomb, to be laid mysteriously in a determinate place, consisted of a metallic sphere of a diameter usually greater than that of the hand grenade (Fig. 4). In addition to its charging aperture, it was provided with two diametrically opposite orifices through which passed a wooden or metallic tube. This tube, furnished with a number of small apertures,

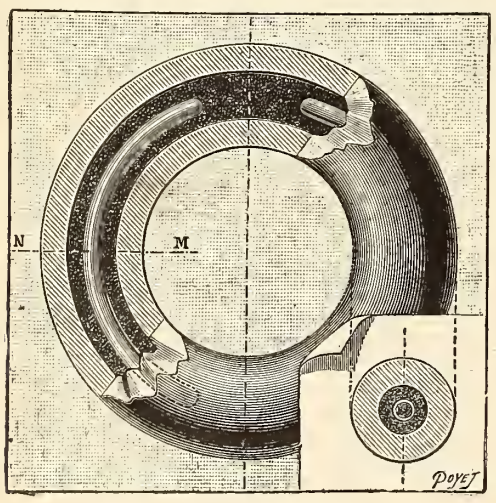


Fig. 8.—RING BOMB (×½).

Plan and section through M N. Curved tube containing an explosive surrounding very fragile glass tubes filled with a liquid that becomes disseminated through the charge and causes its explosion.

was strewed within with very finely comminuted powder, and gave passage to a slow match that was lighted at one end. "It is possible," says Siemienowicz, "to conceal this bomb at the entrance of an avenue or in some other defile through which we shall hope that our enemy is to infallibly pass."

The German engineers of the seventeenth century applied the name of *heimlich* or *leg feuer* to certain pyrotechnical apparatus that were "clandestine," that is to say, that could be "concealed in some secret place, in order to cause them to produce their effects at a certain determinate time." These well dissimulated apparatus were laid "in houses, barns, granaries and similar places; in magazines and arsenals; and finally, in wagons, chests and casks, and such luggage as one may have to carry into the cities and fortresses of the enemy."

Here we have a prototype of the occult apparatus employed in our time for the crime commonly called bomb throwing.

Siemienowicz has left us a description of various types of this weapon. In Fig. 5 we have one whose ovoid wooden shell is "channeled spirally from bottom to top, so that in this spiral groove there may be adjusted and glued a match that passes and winds from one end to the other. This spiral match should be one of those that neither smoke nor stink. Its length is determined by the space of time at the end of which it is necessary that the globe shall produce its effect." As for the charge of this *timed* explosive, that consisted of "violent substances," such as the one of which Brechtel has given the following formula: "Take three parts of gunpowder and one part of sulphur, pulverize the two elements into a very subtile powder, and then incorporate them. Afterward add a little resin and a few drops of turpentine, and then knead all this with linseed oil and alcohol. After well mixing, fill your globe with this composition."

"The petard," says Father Daniel, in his 'History of the French Militia," "is a sort of small mortar which is loaded with the finest kind of gunpowder (Fig. 6). This powder is covered with felt and the latter with a wooden disk. This species of cartridge is driven in by giving it seven or eight blows of the mallet, so as to compress the powder, without, however, granulating it in the least. The rest of the petard is filled with yellow wax and black resin, and the whole is covered with cere-cloth. The petard, at the muzzle end, is set into a thick piece of plank, and the latter is placed against and hooked to the door that it is desired to shatter. Then fire is applied to a small match that passes through the vent in the breech of the petard. The match having communicated fire to the powder, the petard produces its effect upon the door throughout the entire width of the plank and shivers it." This apparatus, called also a *pyloclaste* or "door breaker," was in great demand as long ago as the end of the sixteenth century, after Henry of Navarre had successfully employed it at Cahors in 1579. It was ultimately replaced by the wooden petard of the artillery service, which, in turn, was dethroned by the dynamite petard.

The last year of the eighteenth century witnessed a crime that immediately made a prolonged echo throughout Europe. We refer to the explosion of Saint Nicaise Street of the 24th of December, 1800. The infernal machine in question consisted of a water carrier's cask filled with powder and scrap iron, and placed upon a cart drawn by a pony. The igniter was a gun hammer actuated by a lanyard that one of the conspirators had taken upon himself to pull.

During the course of his expeditions in Africa, Marshal Bugeaud sometimes employed analogous methods. When, in beating a retreat, he was too closely pressed by the Arabs in scattered order, he had a goodly number of cracker boxes stowed here and there back of his column. Now, the natives well knew the form of these special boxes and were very fond of their contents—the *galleta roumia*. They, therefore, made a scramble for the booty that was offered them, and set free the exploding mechanism. The explosion immediately evoked a concert of savage yells, for (is it necessary to tell it?) instead of crackers, the boxes contained a charge of powder, . . . and the Arabs found this charge very bad.

The use of small mines thus arranged in the open air or buried so as to be on a level with the surface of the earth is reglementary in modern armies, wherein they are designated by the generic name of "fougades."

In order to arrange an ordinary fougade by rule, there is dug a small well, AB, which is connected by a trench, BC, with the point where the operator is to stand whose business it is to do the firing (Fig. 7, No. 3). The powder box, A, is placed at the bottom and at one of the sides of the well. The trench allows of the passage of the conductor or the firing line. Things being thus prepared, the well and trench are filled in and the firing is effected at will at the moment that appears opportune.

But an ordinary fougade, a dry torpedo buried at a slight depth, is of a nature to be easily fired automatically; in other words, the explosion may be produced either through a fulminating primer or through the production of an electric current at the precise moment at which a man plants his foot upon its ground plate.

In the first case, the fougade or torpedo is provided with a detonating primer which is actuated by a plate, MN, arranged flush with the surface and covered only with a few inches' thickness of earth (Fig. 7, No. 1). When the plate tilts under the weight of men who are passing, the friction piece of the primer, B, is pulled by the cord, C, fixed to the plate, and causes the detonation of the fulminate.

In the second case an electric primer, D, is placed in the charge, C, and, of the two conductors, one is in constant communication with a battery (Fig. 7, No. 2). The other communicates with the latter only through the intermedium of the plate, which, in ordinary times, is kept raised by means of a spring. The circuit is then interrupted, but, as soon as a shock depresses the plate, and consequently the upright, AB, the circuit is closed and an explosion is produced.

In 1870, the defenders of Paris arranged bombs of this kind behind the glacis of the enciente. On the 22d of August, 1877, the Russians brought similar ones into play, and not without success, in the celebrated pass of Schipka.

The fougade or bomb torpedo is nothing more than a copy of the *ty-lei*, or "earth-thunder," that has been in use in China since a period previous to the Christian era. The apparatus of this kind consists of four bombs of the same caliber inclosed in a wooden box, D, divided into two parts, B and C, by a horizontal partition (Fig. 7, No. 4).

In the upper compartment, B, are arranged the projectiles, the aperture downward and the fusee passing through the partition. In the lower compartment is placed the charge of powder, in which are buried the extremities, AA, of the apparatus that transmits fire. Thus prepared, the box is buried in the earth, flush with the surface, after the manner of the powder box of an ordinary fougade.

Instead of using boxes, bombs simply buried flush with the surface may be brought into play. Such projectiles are grouped according to lines determined by local circumstances. *Chapelets* is the name given to a series of bombs connected with each other by one firing match in common or by the same electrical conductor. The defenders of Badajoz (1812) used to advantage this method of resistance to the efforts of a resolute besieger.

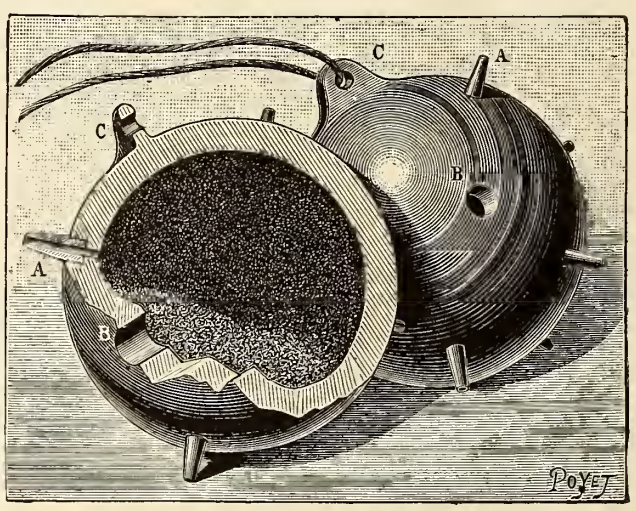


Fig. 9.—THE ORSINIAN.

A A, percussion cap nipples; B B, charging apertures; C, lug serving to throw the projectile.

But here intervenes a discovery fecund in results as violent as unexpected, and which suddenly produces in the processes of the pyrotechnic art a revolution comparable to that which the invention of powder did of old. We refer to the putting of shattering explosives into service.

It was thirty-six years ago that shattering materials inclosed in metallic envelopes and, acting after the

manner of shells fired by guns were used for the first time. This event dates back to the day of the crime of Orsini, Pierri, Di Rudio and Gomey (January 14, 1858). On that day, terrible hand bombs, it will be remembered, mowed down the imperial escort at the foot of the staircase of the old Opera House, situated on Le Peletier Street. The apparatus thrown by Orsini and his accomplices were of three different styles. The covering of the first was formed of a hollow cast iron cylinder 3¼ inches in length and 2¾ in external diameter. It consisted of two parts connected by a screw thread, and was charged with fulminate of mercury and provided at the surface with twenty-two percussion cap nipples so arranged as to assure an explosion at the moment of the fall of the weapon. The second model differed from the first only in the cylinder being provided with hemispherical caps. The third was in the form of a sphere.

In 1870, General de Riviere, having been ordered to proceed to the putting of the place of Lyons in a state of defense, charged some cylindrical grenades, tipped with hemispheres, with disruptive materials. These hand projectiles, prepared by a pyrotechnist of Rive-de-Gier, and duly tried in the interior of an open well back of the fort of Montessuy, were designed to be thrown upon assaulting columns. No occasion occurred to use them at Lyons, but they were employed at Paris at the time of what is called the insurrection of the "Commune," especially at the time of the attack, by the regular troops, of the "Park of Birds," situated between Issy Park and the fortified enciente. It was by throwing these grenades over the coping of a battlemented wall that did us a great injury that it was possible for us to clean the foot of this defensive wall in the interior. After the entrance of our soldiers into Paris, the directiou of the throwing service of these torpedo grenades was intrusted to an officer of miners. These hand projectiles produced formidable effects. The first one that was thrown fell into the shop of a milliner, whose elegant furniture was literally pulverized. But the insurgents of the Commune had these torpedo grenades likewise, and even two models of them. The first, which was of cast iron, had the form of a hollow ring of from 4 to 5 inches diameter (Fig. 8), and contained two small curved, very thin glass tubes that could not fail to break at the first shock, that is to say, at the moment of the projectile's fall. The liquid set free then caused the explosive charge to detonate, and the brittle metallic envelope instantaneously flew into pieces.

The second, called the "Orsinian" (Fig. 9), consisted of a small sphere of brittle zinc weighing about ten ounces. This sphere was hollow. Its external diameter was scarcely two inches and its thickness but about a quarter of an inch. The charge was introduced by two diametrically opposite apertures that were closed by means of plugs after the operation of charging. The apparatus was studded with percussion cap nipples inserted in the summits of regular pentagons inscribed in two parallels taken on each side of the equator at the distance of about half an inch. At a point in this circle there was a lug cast in a piece with the sphere and containing an aperture for the reception of the cord by means of which the projectile was thrown forward. The explosion was produced by the fall of the sphere.

As we have before said, then, the advent of explosives has singularly revolutionized the methods of certain branches of the military art.

We shall refrain from entering into further details concerning the new principles that preside over the execution of campaign torpedo works, and the reason for such desired reticence will be understood. It is because crime is everywhere always on the watch and ready to seize and appropriate to itself the means of action which the artillery and engineering services have at present at their disposal.—*Lieut.-Col. Hennebert, in La Nature.*

[Continued from SUPPLEMENT, No. 964, page 15403.]

## THE RELATION OF MATHEMATICS TO ENGINEERING.*

SUBMARINE telegraphy yields some interesting examples of the application of the higher mathematics. When a cable across the Atlantic was first seriously entertained, the first point to be settled was how many words a minute could be sent through such a cable. This was the most practical question possible. Upon the answer depended the prospect of the cable paying commercially, if successfully laid. The matter was dealt with by Prof. Thomson,† of Glasgow, now Lord Kelvin. He showed that the propagation of an electric disturbance in a cable could be expressed by a partial differential equation, and that the solution of this equation under certain conditions applicable to practice could be expressed either by a definite integral or by a infinite series. The values of these were calculated, and hence before an Atlantic cable was laid at all it was known how long it would take a signal to reach the opposite shore, and how much its intensity would be diminished in transmission. Referring to Fig. 5, abscissæ represent time, reckoned from the time of making contact at the sending end of the cable, ordinates the currents at the receiving ends, curve (1) gives these currents when the contact at the receiving end, after being made, is continuously maintained.

It will be observed that for a time, $a$, there is hardly any current at the receiving end, that then the current rapidly increases and attains to half its final value after a time equal to about $5a$. Curves (1) . . . (7) show the currents at the receiving ends when the contact is made at the sending end maintained for times $a$, $2a$, . . . $7a$ respectively, and then broken. Looking at curve (1) one sees how small is the amount of current and how long it lasts compared with the time during which contact is made. The time, $a$, depends on the length and character of the cable; it is equal to

$$k\,c\,l^2 \log \varepsilon - / \pi^2,$$

where $k$ is the resistance per unit length, $c$ the capacity per unit length, and $l$ the length of the cable. The knowledge of what is the commercial value of a cable depends on a knowledge of the value of $a$, and this cannot be obtained without knowing the differential equation $c\,k\frac{dv}{dt} = \frac{d^2v}{dx^2}$,* to which I have referred, and its by no means simple solution either as a definite integral or as an infinite series. So far as I know, this piece of higher mathematics cannot be evaded by any mere elementary treatment. The transmission of disturbance in a cable is quite different from the transmission of sound waves in air, which move with constant velocity. If the cable be doubled in length, it takes four times as long for the signal to pass through it instead of just twice as long, as would be the case if it were a proper wave motion. In fact, the time of passage between the making of contact at the sending end of the cable and the beginning of the resulting disturbance at the receiving end varies as the square of the length of the cable. The mathematical theory is exactly the same as that of the transmission of heat in a plate, one surface of which is suddenly exposed to a temperature different to the temperature of the plate.

This is constantly occurring in the application of mathematics—one piece of mathematical work serves for many physical problems having apparently little in common. Fourier long ago discussed the heat problem, little dreaming that his analysis would be just what was wanted for ascertaining how fast signals could be sent across the Atlantic by a system of telegraphy which in his days had not even been projected in its simplest form. The same differential equation also gives the theory of the transmission of telephonic messages through cables; but the solution is then easier, and tells us exactly why it is so much more difficult to speak through 100 miles of cable than through

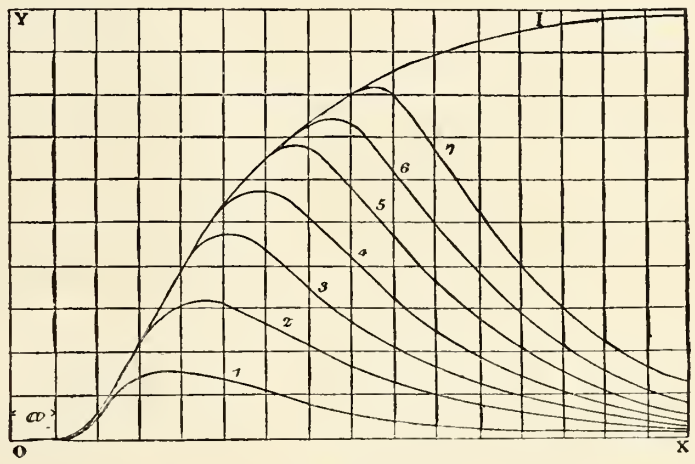


FIG. 5.

1,000 miles of overhead line. As I have just stated, the differential equation of the disturbance in the cable is $c\,k\frac{dv}{dt} = \frac{d^2v}{dx^2}$. A musical note of period T spoken into the cable through a telephone is properly represented by $A \sin \frac{2\pi t}{T}$; the disturbance in the cable will be

$$v = A\, e^{-x\sqrt{k\,c\pi/T}} \sin\left(\frac{2\pi t}{T} - x\sqrt{k\,c\,\pi/T}\right)$$

as may be easily verified by differentiating. This equation tells us everything. It tells us the rate at which the waves diminish with the distance. This rate increases with the resistance, with the capacity and with the frequency. If the capacity is at all considerable, the diminution is rapid. The velocity of the waves is not the same for all frequencies, as is the case with waves in air, but varies as the square root of the period, so that if two notes were sounded, the high note would arrive after the low notes, and the resultant effect would be entirely destroyed. Here, again, it is difficult to see how the differential equation and its solution can be evaded.

Though the history of the telegraph dates only from a little more than fifty years ago, it is ancient in comparison with the other great applications of electrical science, which have received their development during the last fifteen years. Here again mathematics which are not quite elementary have played their part. In the theory of transformers we find another illustration of the need of knowing how formulæ are obtained if they are to be correctly applied. The early transformers were made with unclosed magnetic circuits; there was an iron core, but the lines of magnetic force passed through air for a considerable part of their path. In this case a complete mathematical theory was not very difficult. But speedily closed magnetic circuits were found to be better, and the relation of magnetic induction and magnetic force became all-important. If any one were to apply mathematical formulæ which were true for the earlier transformers to the later ones, his results would be inaccurate. Indeed, a wholly different method of attack on the problem was needed, taking account of the facts as they are, and not applying results which were true of older apparatus to cases essentially distinct. †

The employment of alternating currents has brought into use, as a necessity for understanding the actually observed phenomena, a great deal of mathematics Why is the apparent resistance of a conductor greater for an alternating current than for a direct current? And by resistance I do not mean the quasi-resistance due to self-induction. ‡ The mathematical electrical theory is ready with an answer; it is ready, too, to tell us how the difference depends upon the frequency of the current and on the size of the conductor. In the case of a cylindrical conductor the solution involves a knowledge of Bessel's functions. We learn that if the current has a high frequency, or if the conductor be large, there will be very little current in the center of the cylinder, and that, therefore, for any practical purpose the center of the cylinder might just as well not be there; the current is largely confined to the part of the conductor near to its surface. The currents at different depths in the conductor attain to their maximum values at different times; those near the surface of the cylinder occur before those at some distance from the surface.

The mathematical conditions are expressed by the same equation as is used to express the disposition of heat in a cylinder the surface of which is submitted to a periodic variation of temperature. Any one who had thoroughly mastered the heat problem would be quite prepared to deal with the problem of currents in a conductor. It cannot be too often repeated, any piece of pure mathematics which finds one application to a physical problem is almost sure to find, in exactly the same form, applications to other problems which superficially are absolutely distinct. The differential equation in this case is $k\,c\frac{dv}{dt} = \left(\frac{d^2v}{dr^2} + \frac{1}{r}\frac{dv}{dr}\right)$, the similarity of physical condition to the problem of linear propagation of heat is close, but the mathematics differ materially, owing to the presence of the term $-\frac{1}{r}\frac{dv}{dr}$ in the equation. Mathematics deals with the relation of quantities to each other without troubling as to what the physical meaning of the quantities may be. Hence it is that the mathematical treatment of two such problems as the distribution of currents in a cylindrical conductor and of heat in a cylinder is identical, whereas the treatment of the distribution of heat in a cylinder is quite distinct from the treatment of the distribution of heat in a sphere or in a solid bounded by two parallel planes.

A curious phenomenon was observed in the large alternate-current machines at Deptford when connected to the long cables intended to take the current to London. The pressure at the machines when connected to the conductors was, under certain conditions, actually greater than when not so connected. The phenomenon is one of resonance very analogous to the heavy rolling of ships when the natural period of roll is about the same as the period of the waves.* The period of the alternating current corresponds to the period of the waves, the self-induction of the machine to the moment of inertia of the ship, the reciprocal of the capacity to the stiffness of the ship, and the electrical resistance of the conductors to the frictional resistance to rolling. The mathematics in the two cases is then the same. The effect was predicted long before it was observed in a form calculated to cause trouble.

A problem which is still agitating electrical engineers is that of running more than one alternate-circuit dynamo machine connected to the same system of mains. Before the matter became one of practical concern, it was considered in this room, and it was shown mathematically that it was possible to run independently driven alternators in parallel but impossible to run them in series. That is to say, that if two alternators were connected to the same mains, they would tend to adjust themselves in relation to each other so that their currents could be added, but that if an attempt were made to couple them, so that their pressures should be added, they would adjust themselves so that their effects would be opposed.†

Perhaps of all engineering problems which have received their solution in the last hundred years that of the greatest practical importance is the conversion of the energy of heat into the energy of visible mechanical motion. The science of thermodynamics has advanced along with the practical improvement of the steam engine. By its aid, particularly by the aid of the so-called second law, we know what is possible of attainment by the engineer under given conditions of temperature. I must not trench on the subject of one of my successors, but I may point out that our knowledge of the second law of thermodynamics was first developed by means of mathematics, and that to-day its neatest expression is by means of partial differential coefficients. The two most notable names in connection with the development of the second law of thermodynamics in harmony with the first are those of Kelvin and Clausius; both dealt with the subject in a mathematical form not comprehensible to those who have not had substantial mathematical training.

Illustrations such as these might be multiplied almost indefinitely. They show that the advancement

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* The "James Forrest" lecture, delivered at the Institution of Civil Engineers, by Dr. John Hopkinson, F.R.S., on May 3, 1894.—*Nature.*

† "Mathematical and Physical Papers," vol. ii., p. 61. Sir W. Thomson.

* $v$ is the potential, $t$ the time, and $x$ the distance from the sending end of the cable.

† *Proceedings* of Royal Society, February 17, 1887.

‡ Lord Rayleigh, *Phil. Mag.*, vol. xxi., p. 381.

* Institution of Electrical Engineers, November 13 1884.

† Minutes of *Proceedings* Inst. C.E., April 5, 1883; Institution of Electrical Engineers, November 13, 1884.

of the science of engineering has been aided in no inconsiderable measure by the labors of mathematicians directly applying the higher mathematical methods to engineering problems. They show, too, one way in which respect for a formula may be dangerous, one way in which it is true that mathematics may be a bad master. In St. Venant's problems we have an example in which the use of older results of limited application in cases where the assumptions on which they rest are not true will mislead. The examples show the proper remedy: it is a more complete application of mathematical methods. The error is just one which a man will make who has the power to use a formula without a ready understanding of how it is arrived at. A practical man, ignoring mathematical results, might or might not escape the error of supposing that a triangular shaft would break at the angles under torsion; the half-educated mathematician would certainly fall into the snare from which complete mathematical knowledge would deliver him. You can only secure the services of that good servant, mathematics, and escape the tyranny of a bad master, by thoroughly mastering the branches of mathematics you use. The mistake caused by the wrong application of mathematical formulæ is only to be cured by a more abundant supply of more powerful mathematics.

There is another drawback to the use of results, taken, it may be, out of an engineering pocketbook by those who are not prepared to understand how they are reached and on what foundations they rest. The educational advantage is lost. The close observation which enabled the earlier engineers to proportion their means to the ends to be attained was no doubt very laborious, and the results could not be applied to cases much different from those which had been previously seen, but the effect on the character of the engineer was great. In like manner, to thoroughly understand the theory of an engineering problem makes a man able to understand other problems, and in addition to this precisely the same mathematical reasoning applies to many cases. The mere unintelligent use of a formula loses all this; it leaves the mind of the user unimproved, and it gives no help in dealing with questions similar in form, though different in substance.

But even the use of mathematics by competent mathematicians is not without drawbacks. Mathematical treatment of any problem is always analytical—analytical, I mean, in this sense, that attention is concentrated on certain facts, and other facts are neglected for the moment. For example, in dealing with the thermodynamics of a steam engine, one dismisses from consideration very vital points essential to the successful working of the engine, questions of strength of parts, lubrication, convenience for repairs. But if an engineer is to succeed, he must not fail to consider every element necessary to success; he must have a practical instinct which will tell him whether the instrument as a whole will succeed. His mind must not be only analytical, or he will be in danger of solving bits of the problems which his work presents, and of falling into fatal mistakes on points which he has omitted to consider, and which the plainest, intelligent practical man would avoid almost without knowing it.

Again, the powers of the strongest mathematician being limited, there is constant temptation to fit the facts to suit the mathematics, and to assume that the conclusions will have greater accuracy than the premises from which they are deduced. This is a trouble one meets with in other applications of mathematics to experimental science. In order to make the subject amenable to treatment, one finds, for example, in the science of magnetism, that it is boldly assumed that the magnetization of magnetizable material is proportional to the magnetizing force, and the ratio has a name given to it, and conclusions are drawn from the assumption, but the fact is, no such proportionality exists, and all conclusions resulting from the assumption are so far invalid. Wherever possible, mathematical deductions should be frequently verified by reference to observation or experiment, for the very simple reason that they are only deductions, and the premises from which the deductions are made may be inaccurate or may be incomplete. We must always remember that we cannot get more out of the mathematical mill than we put into it, though we may get it in a form infinitely more useful for our purpose.

Engineers no doubt regard their profession from very different points of view; some think it a mere means of making money; some regard it as an instrumentality for benefiting the race; while others again delight in it as an interest in itself, and delight in it most of all when new knowledge is added to that which we know already. It is just the same with the medical profession; some attend patients for the guineas they receive, some give a very high place to motives of benevolence, while others love it as a field where new knowledge may be found and the delight of discovery enjoyed. In regard to the first class of engineers, I have no doubt a little skill in managing a board of directors or impressing a committee of Parliament will be much more useful to the engineer than a great deal of mathematics. Let him manage his board and buy his mathematician, and it is very probable he will make much more money than the mathematician or any other person of skill whom he may employ. But we cannot all of us make money in this way. In the future it is likely that educated men will have to work harder and receive less, and it is a great thing if their work can be made itself a joy, and surely this can best be by a thorough understanding of the reason of all they do by the feeling that they have full competence to form their own judgments without depending much on the authority of others. This can only be, in the words of Sir John Herschel, by a "sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advance in any of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range."

After all, in any department of applied or pure science the highest satisfaction comes from accomplishing that which no one has done before, from disclosing what no one hitherto has known. If a department of the arts or sciences ceases to advance and becomes simply the application in known ways of known principles to obtain known ends, that department has lost its charm till the time comes for a fresh advent of change and development. To effect such advances it is easy to show that mathematics is a most necessary instrument. Here it is no drawback that the mind of the discoverer is too analytical; he may deal at his pleasure with one aspect of a problem, and it does not detract in any way from the value of his solution that he does not touch on incidental matters. Some of you who love the interest of continual advance in our science and practice may look forward with a shade of sadness to a possible time when all is done or known which can be done or known, and the work of the engineer shall be merely applying principles discovered by his predecessors. In such a state, when the experience of the older generations shall control the practice of to-day, the free use of mathematical methods may be effectually superseded by the application according to rule of mathematical formulæ. But it would be a much less interesting condition than the constant change of to-day, when the practical experience of ten years ago is in many departments rendered worthless by later discoveries. But we need not fear that such a time of petrifaction will come so long as, while reverencing the discoverers who have added to our knowledge, we endeavor to replace their methods by better, and expect that those who come after us will, in their time, improve upon ours. Our knowledge must always be limited, but the knowable is limitless. The greater the sphere of our knowledge, the greater the surface of contact with our infinite ignorance.

[Continued from SUPPLEMENT, No. 964, page 15405.]

## NICKEL—ITS HISTORY, USES, AND DISTRIBUTION.*

By A. G. CHARLETON, A.R.S.M.

I HAVE here some interesting geological sections, copied after Levat, describing the features that have been mentioned. Deposits closely approaching in

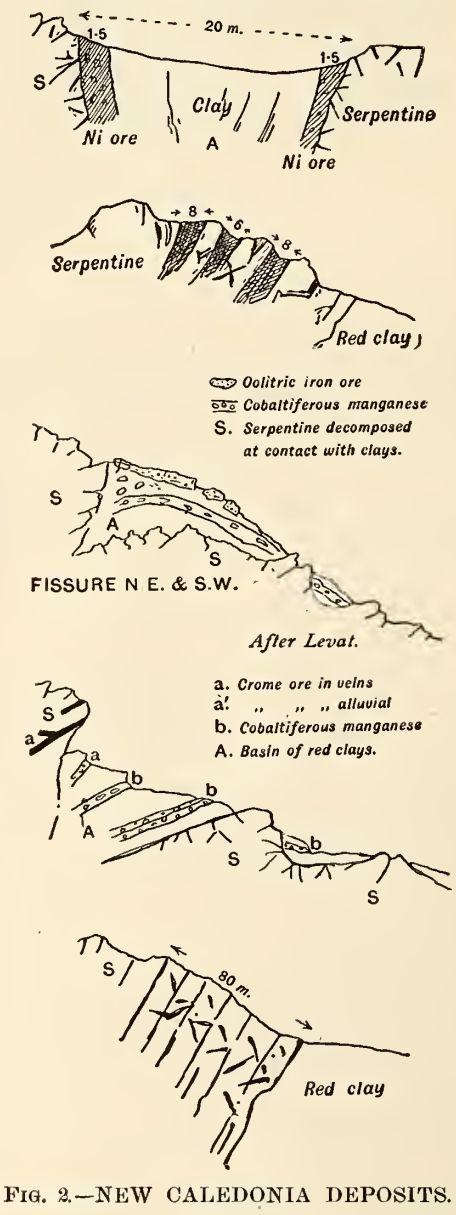



FIG. 2.—NEW CALEDONIA DEPOSITS.

type those just described were discovered in 1881, at Riddles, Douglas Co., Oregon, and others of a similar kind have been found at Webster, North Carolina. The Riddles deposits all lie at or near the surface, in beds 4 to 30 feet thick, occurring as a bowlder formation, scattered through a ferruginous earth or in beds underlaid by serpentine, and associated with chrome iron.

F. W. Clarke, *American Journal of Science*, vol. xxxv., p. 483, gives a typical series of analyses, which show that the relative composition of silicate minerals obtained from New Caladonia, Oregon, and North Carolina agree very closely in composition and appearance. A fresh specimen of "country" was analyzed from Oregon, and some olivine was found in it. The rock contained 0·10 per cent. NiO, the olivine 0·26 per cent. NiO.

This suggested to Clarke a probable source of derivation of the nickel in the altered beds of ore, and the microscopical investigations of Diller confirm his view. He considers the Riddles rock as belonging to the peridotes. It is a holocrystalline, granular rock, composed essentially of olivine, while one-third of the rock mass consists of enstatite, with a small percentage of chromium and magnetite. Quartz is present from metasomatic change, and whenever genthite appears it is always associated with quartz or serpentine. The genthite occurs in the serpentine, directly connected with the grains of olivine, from which the serpentine has been derived, and Diller states there is every reason to think the genthite is primarily derived from the same source. Though the Webster rock (which is also a peridote, of the variety known as dunite) contains less enstatite, and the nickel silicates are not so closely intermixed with quartz, the relation of the genthite to the serpentine and olivine is the same as at Riddles. Of the New Caledonia genthite, Diller says, like that of Oregon, it is disposed in layers and cavities, thoroughly intermingled with quartz, and sections show the serpentine with traces of olivine and enstatite so disposed as clearly to indicate that the serpentine naumeite, and other secondary products, have resulted from the alteration of the peridote rock.

According to S. H. Emmons (*American Mining Journal*, April 30, 1892), the nickel deposits of North Carolina are found in veins of three distinct classes—1, those occupying fissures, the strike of which is more or less normal to the planes of division, that give a bedded aspect to the chrysolite rock mass, and there are numerous counter veins, with a strike oblique to the first series; 3d, there are bedded veins, located in planes of division. He is of opinion that the counter and bedded veins will not be found very productive, and the first series will alone yield any considerable supply of ore.

A nickel iron josephinite has been lately discovered, in the form of pebbles and smooth bowlders, in considerable abundance in the placer gravels of a stream in Josephine County, Oregon. They are supposed to have been derived from some dike of ultra-basic rock.

Melville has described this alloy (*American Journal of Science*, vol. xliii., p. 509), which is highly magnetic. The pebbles are a greenish black, with bright areas of a grayish metal. The greenish black portion consists of silicates, some of which are indissoluble in HCl. Nickel is found in the Urals at Rewdinsk, in veins six feet wide, between chloritic schist and serpentine, as well as in a great many places in other parts of the world. At the Kelsey Mine, Los Angeles Co., California, Ni and Co ores are found in the comparatively rare form of arsenates, together with silver glance and native silver, in a fissure vein in close relation with a diorite dike. The assorted ore contains 7 per cent. to 15 per cent. cobalt, 2 to 3 per cent. nickel, and 1,000 to 1,400 oz. of silver per ton. Rich nickel ore has also been found in the Gem Mine, Fremont Co., Colorado, in a hornblende schist occurring as an arsenide and sulpho-arsenide, some of the specimens being so permeated with fine wire silver as to be difficult to break. At surface the ores were mostly copper, but at a depth of 15 to 20 feet nickel was struck, and continued down to 75 feet, when the vein, which had averaged 3½ to 4 feet, cut out and appeared to be lost, but on resuming sinking, a streak of ore about 18 inches wide was struck containing the same minerals and supposed to be a continuation of it, though this has not been definitely proved. Small shipments of this ore ran from 12 to 34 per cent. nickel and 2 to 4 per cent. cobalt; the last lot shipped to England contained most of the nickel as niccolite. The ore streak is unfortunately narrow, the walls hard, and the ore difficult and expensive to mine. Nickel is known to exist in the hornblendic rock near Salida, Colorado. The serpentines of the west of Ireland and Cornwall, and indeed almost all serpentines, contain a little nickel, and it is met with in Australia, New Zealand, and South Africa. Sufficient has therefore been said to show that nickel ores are widely distributed over the world, though in the present condition of our metallurgical knowledge of the subject payable deposits are less numerous than those of most of the common metals.

### THE GENESIS OF NICKEL.

To explain the genesis of this class of ore deposits one must glance for a moment at the sources from whence nickel is derived. Native nickel is found alloyed with iron in meteorites, and also in some ultra-basic lavas, while the spectroscope reveals its presence in the solar atmosphere. It is showered on the surface of our planet in the form of meteorites, those fiery messengers telling of the wreck of other worlds, and testifying to the common origin of the material universe, in the form of 1, holesiderites, composed entirely of nickel iron; 2, syssiderites, the nickel iron of which contains silicates of magnesia and iron protoxide, identical with olivine, and at other times a mineral resembling augite; 3, sporadosiderites, the most common kind, usually crystalline in structure, and containing nickel iron, troilite, chrome iron, olivine, titanic and phosphoric acids; 4, asiderites, distinguished by the presence of hydrocarbons in which nickel is present as an oxide. Some of them have been shown to contain pyroxine and feldspars (chiefly anorthite) and the absence of quartz and highly silicated feldspars is to be noted. These four classes of meteorites show a gradation from almost pure metal containing over 98 per cent. of nickel iron to a stony mass closely resembling some basic lavas.

Now, according to the last determinations of Mons. Alphonse Berget (*Comptes Rendus*, July, 1893), the density of the earth is about 5·41, while, so far as our limited observation extends, that of the crust is about 2·5. Various theories have been advanced to account for this, and some very first-rate authorities have suggested that the heavier metallic elements might possibly be found to predominate in the nucleus, basing their views on widely extended observation of past and present volcanic phenomena.

It has been found that once the acid stage is past, lavas become more basic, and while each succeeding flow from any one vent might not be more basic than the preceding one, yet the tendency is in that direction till, finally, ultra-basic lavas are extruded from the centers of intense and long continued activity. This average order invariably, I believe, holds good everywhere over the earth's surface, provided the volcanic force is long enough active. The ultra-basic

*A paper recently read before the Society of Arts.—*From the Journal.*

rocks have in composition many points of resemblance to some of the above-mentioned meteorites.

This dunite is a crystalline granular aggregate of olivine and chrome iron, which passes by alteration into serpentine: we have also picrite, half of which is olivine, associated with hornblende, diallage, and magnetite. Lherzolite is another of these peridote rocks, consisting of olivine and enstatite, with other accessory minerals. Olivine is the dominant constituent of such rocks, and as a class they possess the highest specific gravity and least oxygen of any known.

Some of the basalts, notably those of Antrim, in Ireland, contain metallic iron in microscopical particles, and Prof. Nordenskiold discovered in 1870, on the shores of Disco, on the coast of Greenland, at Ovifak, fifteen blocks of nickel iron within an area of half an acre, the two largest being 20 and 8 tons weight respectively; while further observations in the same locality showed that a basalt dike, at no great distance from the supposed meteorites, contained lenticular disk-shaped blocks of precisely similar iron, and crystals of labradorite and arigite associated with viridite, round which minute particles of iron were moulded.

These facts led Professors Judd, Daubree and others to decide that the blocks of iron Nordenskiold discovered and took to be meteorites were of terrestrial origin, as the basalt was certainly not derived from the clouds.

The Ovifak iron contains 0·5 to 6·5 of nickel, and a nickel iron awaruite, lately discovered in New Zealand, presumed also to be of terrestrial origin, is said to contain 68 per cent. Ni, 31 per cent. Fe and 0·7 per cent. cobalt.

In the Urals platinum is found alloyed with nickel iron in association with olivine. Taking the mean density of awaruite as approximately 7·1, and that of rhyolite as 2·6; the terrestrial basic and ultra-basic rocks, which include basalt, gabbro, lherzolite, trachite and dolerite, are found to closely correspond in density with the extra-terrestrial meteorites. Those of solid nickel iron have a specific gravity of 7·1 and graduate down to stony asiderites, which possess a density of 2·7.

*Meteorites.*

| | Sp. gr. |
|---|---|
| Nickel iron solid | 7·1 |
| " considerable | 6·8 |
| " medium proportion | 3·5 |
| " small quantity | 3·1 |
| Stony | 2·7 |

*Terrestrial metals and rocks.*

| | Sp. gr. |
|---|---|
| Awaruite | 7·1 approx. |
| Nickel iron in Ovifak basalt | 6·8 " |
| Basalt, gabbro, lherzolite | 3·0 to 3·5 |
| Trachyte and dolerite | 2·7 to 2·9 |
| Rhyolite petro-silex | 2·6 |

The conclusion to be drawn appears to be that the genesis of nickel deposits may, in most instances, be traced to the ultra-basic rocks, and their derivatives, serpentines and magnesian silicates. The great nickel deposits of the world are found in rocks in which olivine is the predominant mineral, while we have seen that olivine and the magnesian silicates are found not only in the ultra-basic rocks of the earth, but also in meteorites. While these facts alone do not prove that the nickel was derived from the olivine, it is well to note the conditions under which the olivine was formed and to see how far it is nickeliferous. Assuming a semi-metallic nucleus for the earth, and that in this nucleus iron and nickel are the predominant metals, as they are in meteorites, and allowing that the ultra-basic rocks came from the greatest depths in the earth's interior, under such circumstances it would not be remarkable for silicates, crystallizing out of the magma, to contain such metals.

From the microscopic study of the igneous rocks, much light has been thrown on the order of crystallization of their component minerals, which has pretty definitely been proved to be fairly uniform. Thus the first minerals to form appear to be magnetite and ilmenite, sometimes chromite and picotite. Next come silicates, which occur in minute quantities, such as zircon and titanite; pyrite and pyrrhotine usually follow; and next the metallic oxides and sulphides, and the heavy dark colored basic silicates, olivine, augite and hornblende.

Olivine is the first of the rock-forming silicates to crystallize out of the basic magna. According to "Rutley," p. 117, olivine sometimes contains traces of titanic, phosphoric and chromic acids, and the protoxides of nickel and cobalt.

Sandberger's experiments with rock silicates almost invariably show traces of Ni, Co and Cu, from olivine and augite: whether the nickel occurs, as he supposes, in chemical combination, or, as A. W. Stelzner thinks, mechanically admixed, is practically immaterial to the question under discussion; it is sufficient to know that olivine contains the metal in quantity enough to form, when dissolved and reprecipitated, rich and extensive deposits. We have seen, indeed, that the olivine in the Oregon rock gave 0·25 per cent. Ni, while the serpentine from Dillenberg showed 0·66 per cent., and much of the serpentine in New Caledonia runs over 1 per cent.

A review of the foregoing facts certainly points to the conclusion that the nickel, at least of the serpentinous deposits, has been derived from the basic magnesian silicates of the original rock masses. As regards the nickeliferous pyrrhotite deposits, they may possibly have a different origin, as suggested by Vogt.

It has been proved that workable deposits of titaniferous iron have been probably formed in certain basic eruptives in Norway and Sweden, by a process of differentiation or segregation of the iron ore to the center of the eruptive mass; and Vogt has suggested, and endeavored to apply, the same theory, to account for the formation of the nickel sulphide deposits in the norites of Norway and Sweden and the Huronian deposits of Canada. As against this theory, it is remarked that the pyrrhotite deposits referred to occur along the contact planes of the gneiss and schists; and, therefore, if they were formed by segregation from a molten magma, this process has taken place from the center toward the outside, or in reverse order to that which characterizes the iron ore and the supposed structure of the interior of our globe.

Though there may be grounds for further investigation in this direction, these ore bodies would seem more probably to have been deposited from circulating mineral waters. Some geologists explain the presence of deposits of mineral by supposing them to have been formed by the agency of circulating solutions bringing them to the surface from unknown depths, disregarding the fact that fissures have never yet been proved to have indefinite extension, nor can water circulate below certain limits.

Before, therefore, adopting an ascension theory for the formation of nickel deposits in basic eruptives, it is well to recollect that these rocks came from greater depths within the earth than circulating water is likely to have penetrated; much deeper in all probability than any vein fissure could have extended to.

It is more rational, it seems to me, to suppose that the metals were brought within reach of surface agencies, and it is probably owing to the subsequent leaching of these basic eruptives that our principal deposits of nickel were placed at the disposal of the miner's pick. The practical lesson to be gathered from this is,

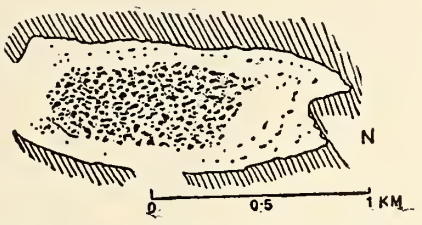



FIG. 3.—SEGREGATION OF IRON ORE.

I think, that the "prospector," looking for new deposits of this class, will best turn his attention to a field where rocks of this character are met with.

The progress of science day by day makes the art of mining less speculative and more business-like, and it should be, I think, the function of the engineer to apply science to this legitimate commercial end; to raise it, in fact, into the position of an "industry," which has materially assisted in building up the prosperity of all new countries; which has done so for America already, and which will do so for our British colonies in the future, with marked advantage to us.

Mining supports tens of thousands of our population, opens outlets for remunerative enterprise and emigration, and exercises a civilizing influence, which is world wide, and, I think, the surest means to foster it is to point out its risks, as well as its advantages; to encourage the employment of necessary capital in profitable fields; and, equally, to discourage wasting valuable money on enterprises which do not possess the elementary conditions for achieving success. There are, in fact, three classes of people, I believe, who engage in mining: those who get most "metal" out of the pockets of the public, those who are content to mine in "pockets of ore," and those whose endeavor is to successfully develop valuable mineral deposits on what I would term a profitable commercial basis, with the aid of scientific knowledge applied practically.

The contracts for the metal in America closed early in 1892 were made at prices ranging from 55 to 60 cents per pound, these quotations being for metal of 98 to 99 per cent. fine. Later on very good nickel of the same fineness has been offered at 52 to 54 cents, and at the close of 1892 could be bought for 50 cents. The dry process has greatly tended to cheapen the cost of producing nickel, but this, it must be recollected, is offset when there is a demand for metal of extreme purity, which can only, as yet, be obtained by wet treatment. This feature of the nickel confers a great advantage on the New Caledonian ores; to illustrate it, it may be stated that the leading nickel refiners in the United States asked 70 cents per pound for metal of first-class quality, while the price asked for the regular 98 per cent. grade was 56 cents prepared from the same ore.

In presenting you with these notes, I have to acknowledge my indebtedness to the papers of Mr. W. S. Austin and Mr. Ph. Argall, before alluded to, and I regret that the limits of this paper will not permit me to enter into the ore dressing and metallurgical treatment of nickel. Both are subjects of special interest to mining men like myself, owing to the important place nickel may take in the future in many branches of the arts and engineering construction, provided only it can be produced at a more moderate cost than it can be placed on the market for at the present time; a necessary condition, which, in time, will certainly be attained.

I have to acknowledge my indebtedness to Prof. Judd and Mr. Gregory for a series of specimens they have most kindly lent me to illustrate the rocks and ores I have referred to.

Mr. Charleton, in reply to questions, said the production of nickel ores in New Caledonia was certainly on the increase. In 1890 the production was 22,690 tons and in 1891 35,000 tons. The lowest price at which it had yet been sold in America was 48 or 50 cents, and though the Americans expected it to come down to 36 cents, he thought that was rather a distant prospect at present. That was for ordinary 98 per cent. quality; that made by the wet process involved a higher cost. With regard to the North Carolina mines, the deposits occupying fissures, the strike of which was normal to the plane of division of the chrysolite mass, were considered likely to be most productive. He had heard recently something about the Mond process, which, he believed, was being tried on a working scale in the States, but he had not yet been able to obtain full details. With regard to the deposits of iron ore containing nickel, though the presence of the latter metal was a decided advantage in certain classes of steel, he did not think it could be considered so in iron; it made it "red short," especially with a low tenor of carbon, and therefore was extremely deleterious above a very small percentage. The chairman's explanation of the origin of the name was probably correct. His intention was certainly not to suggest that the prospector should confine his attention to any particular class of deposits; he knew the unexpected often happened, and the case mentioned in North Wales, where the deposit of nickel occurred in limestone, was somewhat parallel to one he had mentioned in the paper: the occurrence of millirite in calcite in Iowa, mentioned by him. Of course, almost any statement with regard to mining must be made in more or less general terms; one could not dogmatize, and say that such a thing would always happen; the exception was always sure to turn up, and prove the rule. All he wished to point out was that ultra-basic rocks, containing olivine, offered a likely field in which the prospector should look about him with the idea of discovering nickel, though such rocks might cover a large area and yield none.

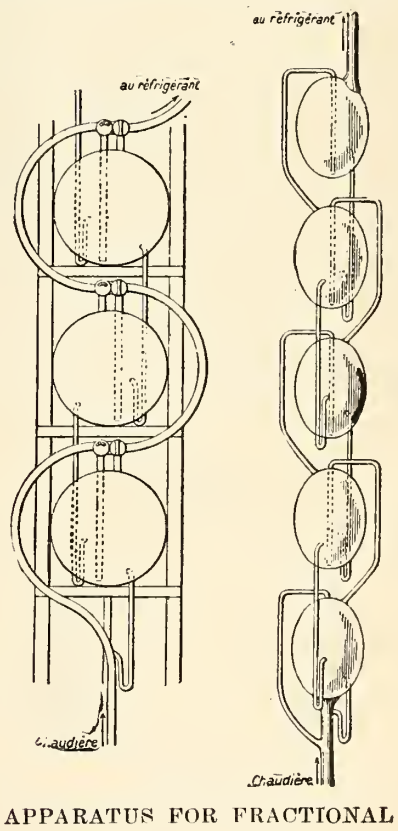
## THE BEST TEMPERATURE FOR GAS PRODUCERS.

HERR R. ERNST has been experimenting with a view to ascertaining the conditions under which producer gas is made from air and carbon. Coke was coarsely powdered, freed from dust by sifting, and roasted at a very high temperature in a Hessian crucible to remove hydrocarbons. It was then burnt in a current of air passing through a porcelain tube heated in an ordinary combustion furnace; and the resultant gases were arrested and analyzed. The temperature of the interior of the tube was checked during the experiments by means of a Le Chatelier pyrometer. The length of the layer of coke, the rate of passage of the air, and the temperature, were independently varied in the experiments. As a general result, it was found that the composition of the gaseous products of combustion depended almost entirely upon the temperature at which the operation was effected. The formation of carbonic oxide and carbonic acid began at about 400° C.; the production of the latter increasing rapidly up to 700° C., when it constitutes about 20 per cent. of the gases collected. The amount of carbonic oxide at this temperature is still small; being only about 3 per cent. of the total. With a further rise of temperature, however, the proportion of carbonic oxide increases at the expese of the carbonic acid, until at 1,000° C. it forms one-third of the gases; the bulk of the remainder being nitrogen from the air. It was shown that at this temperature combustion results in the direct production of carbonic oxide, for the usual process of the reduction of the carbonic acid to carbonic oxide could not be completely carried out under the conditions of the experiment. It is the author's conclusion from this that, since carbonic oxide is the only oxidation product at 1,000° C., generator gas should always be made at this temperature. The experiments are held to explain why carbon burns at a moderate heat without flame, but shows a flame at a brighter heat.

## NEW APPARATUS FOR FRACTIONAL DISTILLATION.

MR. EUGENE VARENNE has just presented to the Chemical Society a new apparatus for fractional distillation which is worthy of being brought to the notice of our readers, since it is both a laboratory instrument and an industrial apparatus.

Fractional distillation, as well known, was especially applied in laboratories of organic chemistry by the lamented chemist Wurtz. He was the first to devise an apparatus which is still employed under the name of the Wurtz tube. Two of his pupils, Messrs. Le Bel and Henninger, greatly improved the Wurtz tube and




APPARATUS FOR FRACTIONAL DISTILLATION.

constructed the ordinary apparatus that is now widely distributed among laboratories.

Mr. Varenne, who likewise was a pupil of Wurtz, has just effected a new progress in fractional distillation through the contrivance of the apparatus represented in the accompanying figures.

For chemical laboratories, the apparatus may be made of glass, and will permit of easily effecting the fractional distillation of liquids at very approximate points of ebullition. For the industries, it is constructed of copper or iron.

It is well adapted for the delicate distillation of benzine or toluene, and it is applicable to all distillations, whatever be the boiling points of the liquids. It suf-

fices to vary the number of the bulbs according as the liquids boil at more or less elevated temperatures.

It is principally in the rectification of alcohols that this apparatus gives good results.

The following, according to the communication made by the inventor to the Chemical Society of Paris, is a comparative table of the rendering of the different apparatus:

| | |
|---|---|
| Savalle apparatus | 1·580 |
| Le Bel-Henninger apparatus | 1·560 |
| Claudan-Morin apparatus | 1·530 |
| E. Varenne apparatus | 1·083 |
| Theoretical coefficient | 1·025 |

The new apparatus is, therefore, the one that most nearly approaches the theoretical coefficient.—*Le Genie Civil.*

## OPERATION FOR CATARACT.

THE operation for cataract was recently performed upon Mr. Gladstone at the residence of Lord Rendel, in London, by Drs. Nettleship and Habershon. It was completely successful, and the aged statesman, who was cheerful during the performance of the work, has since been receiving the congratulations of his friends, among whom was the American ambassador. This operation which Mr. Gladstone has just undergone represents, says the N. Y. *World*, one of the highest triumphs of surgery. It requires a precision and delicacy of touch which no other operation calls for, and it necessitates the employment of instruments so fine that a hair's breadth differentiates one from the other.

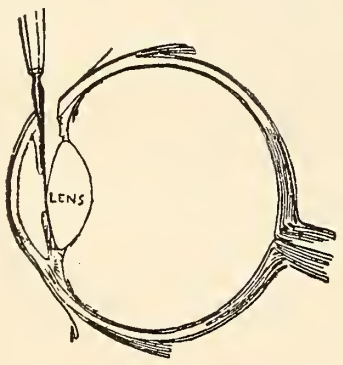
GLADSTONE WEARING HIS EYE SHIELD.

Of all the human organs, the eye in its structure and functions is the most wonderful as well as the most delicate. Within the compass of less than an inch this organ embodies tissues which enable the mind to see and a lens which adjusts itself to every focus by an instinctive and unconscious process. The only result of the operation for cataract which Mr. Gladstone has just undergone, and which is performed every week in this city, is the loss of this little lens in the eye. That loss will now be supplied by eyeglasses of varying strength, but they are clumsy and awkward compared with the marvelously perfect lens which nature puts into the eye of every man.

Although the lens is embedded deep in the eye, it has nothing whatever to do with the delicate adjustment of sensitive nerves less than an inch away that enable a man to see. The faculties of sight are not at all impaired or in any way affected by the operation for cataract, although the latter involves very deep cutting into the eye and the removal of one of the parts which go to make it a perfect seeing organ.

The operation upon Mr. Gladstone was performed at 9 A. M., and did not take longer than fifteen minutes. There have been many occasions when the operation for cataract has been performed twice upon the same person in less than an hour, when both eyes were affected. In very old people a cataract in one eye is generally followed by a cataract in the other. Oculists in this city now believe that Mr. Gladstone will again have to undergo this operation, and perhaps he may do so within a month.

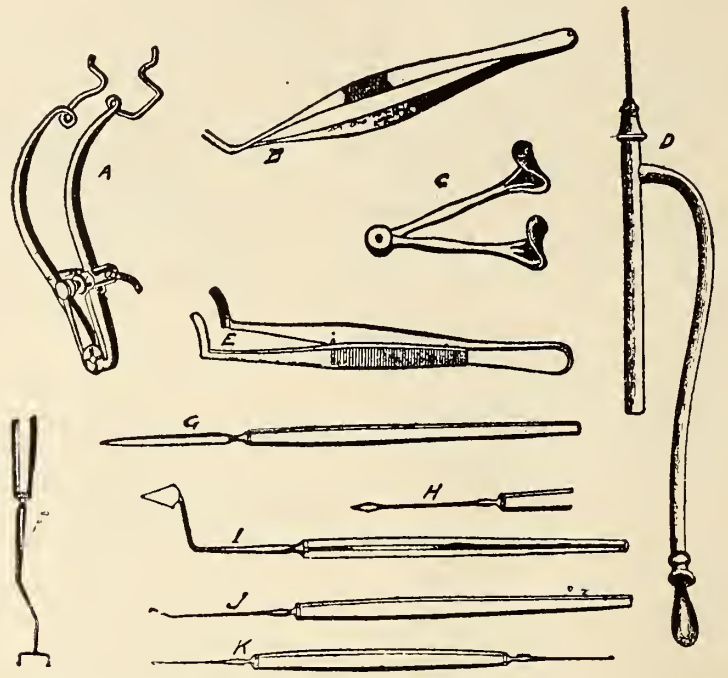
The operation for cataract has become almost painless since the introduction of cocaine, and no anæsthetic was used in the case of Mr. Gladstone. The greatest inconvenience of the patient, however, comes from the enforced incarceration in a dark room for several weeks following the operation. This is to enable the tissues of the eye to heal before any work is thrown upon that organ. The light is gradually let into the darkened room, and the patient, at the end of about three weeks, is released fully cured.




CUTTING OUT THE LENS.

It would be almost impossible for any one but an experienced oculist to tell that the eye had been operated upon. It is apparently natural and unimpaired in every respect, being full and round, of good color, and exactly like its fellow. Similarly, it is very difficult to detect the presence of a cataract in the eye for any non-professional. Many people think that they can tell when a man has a cataract, and that they can pick out the victims of this disease when walking along the streets. Oculists know that this is a fallacy, and what is regarded as a cataract is not that at all, but some other affection of the eye. A curious thing about this disease is that it is not confined to human beings, and that cataracts are frequently found in the eyes of animals.

Another curious fact about the cataract is that no one knows what causes it. The men of science have not failed to advance theories and speculations as to the cause of the disease, but there is no unanimity of opinion among them on this subject. Attempts have also been made to cure the cataract without resort to the knife, but these are regarded as unsuccessful, and the surgical and scientific world agrees that an operation—which is the last resort of science—is in every case necessary.




SURGICAL INSTRUMENTS USED FOR REMOVING CATARACT.

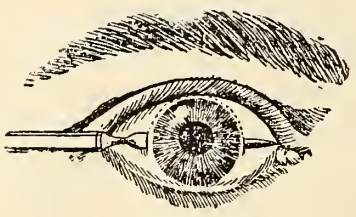
A, eye speculum; B, capsule forceps; C, lid retractor; D, instrument for exhausting soft cataract; E, trachoma forceps; F, ophthalmostate; G, knife; H, cataract needle; I, angular shank kertome; J, cystotome; K, double instrument.

The idea of operating surgically upon the human eye is one that is appalling when first presented to the mind. He was a bold man who ate the first oyster, but he was bolder yet who made the first operation for cataract. It is believed that the ancients were familiar with the operation. There are passages in Galen and Pliny which are thought to refer to the removal of cataract. These, however, could not have been highly successful. The practice fell into disuse among physicians and surgeons until the middle of the eighteenth century. Even then it was attended with great risk and difficulty, and the percentage of failure was very high.

Now, however, while the operation for cataract requires the utmost skill, the chances of losing the eye are only three out of one hundred. Statistics are accurately kept of the operations for cataract, and every case of failure and success is noted.

There are only two cuts of the knife made in the operation, although a multitude of beautiful and delicate instruments are manufactured for the purpose. One of these cuts almost slices off the front of the eye, but it is a singular thing that, although it severs the delicate covering and goes deep into the interior of the organ, it heals up perfectly and leaves almost no mark. A cataract grows on the inside of the eye. It is not on the outside of the eye, as is generally supposed. The sufferer becomes conscious of its existence generally by a gradual diminution of the power of sight. This is not because the organs of sight in the back of the eye are affected, but because the cataract affects only the little crystalline lens which intervenes.

This lens is affected by losing its crystalline quality and becoming somewhat opaque. It acquires a whitish color, and the power of sight is gradually lost as the lens becomes more and more opaque. A singular thing about this lens must here be explained.



THE UPWARD CUT.

While it is really a little sac of liquid, shaped like the ordinary convex lens, it yet contains in its center an actual lens of clear gristle that is hard and strong. This is surrounded by clear liquid. The shape of the entire lens is constantly changing in daily life. When you look at a mountain ten miles off the lens in your eye is of one shape, but when you look at the ground at your feet it instantly changes its shape, so as to bring the subject looked at into focus.

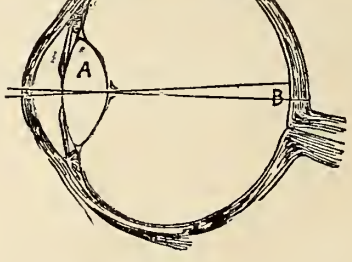
As the whole of the lens is affected in a cataract, its entire removal from the eye is necessary. If it were not for the little hard lens in its center the entire lens might be taken out through a small opening made with an instrument, being run out like so much water. But the little hard lens is more than a quarter of an inch across its face and an eighth to a sixteenth of an inch in thickness. It can only be removed through a slit cut down to the center. This is the first cut which is made.

In performing the operation it is necessary that the eye should be kept immovable. The patient could not do this himself. The oculist first inserts a speculum, which keeps the eyelids far apart and the eye wide open. The patient might, however, move his eye with the speculum in place. This is prevented by the use of a forceps, which grasps the skin of the eye below the eyeball and holds it firmly. This is generally held by an assistant of the operator. Another assistant holds a large magnifying glass which concentrates the light on the eye and illumines its interior.

The patient always undergoes the operation after having had a rest. That is the reason the operation on Mr. Gladstone was performed early in the morning. This is the time of day invariably selected by oculists, because the patient is fresh from his bed and thoroughly rested. Oculists also prefer to perform the operation by artificial light, which seems to be softer and more congenial to the eye than the light of day.

A *World* reporter, who called upon an eminent oculist in this city recently, enjoyed the rare opportunity of seeing the operation for cataract performed. In this instance a human eye, taken from a bottle of alcohol, was used in illustration, being placed in the mask or false face which oculists use for this purpose. The knife with which the first cut was made had a blade that was about an inch in length, sharpened on one edge, with a very sharp point. As soon as the oculist began to work upon the eye it became apparent that that organ in the body is by no means as delicate as is commonly supposed. This was not because of the alcohol in which the specimen had been placed. "The eye is really well protected," said the doctor. "In the operation for cataract considerable muscular pressure is required. People generally think the eye is a bag of liquid contained in a thin film. As a matter of fact, it is protected by a covering that is almost as tough as leather."

It was apparent when the first cut was made that the operator requires strong hand and fingers. The knife was run into the eye horizontally from the outside. After the first puncture it was pressed steadily through the center of the eye toward the nose, until it came out upon the other side. The coverings of the eye which were being cut seemed to be of the consistency of India rubber. The knife was inserted with its edge upward. Then the upward cut was made from this position, the knife being worked backward and forward until it came out at the top of the eye. This left a sort of flap.




CROSS SECTION OF EYE.

A, lens, which is removed. D, retina.

The patient always reclines on his back, and the flap remains in a natural position until the next instrument is inserted. This is really a long needle with a slight elbow, on the end of which is a minute point projecting inward with a knife edge on its upper surface. The little knife which this instrument carries on its point is so small as almost to be invisible to the naked eye. Its purpose is to cut the sac containing the lens, which has thus far escaped the knife. This instrument is inserted through the cut which has just

been made from the top and at an angle projecting outward. When its end has passed the center of the eye the operator changes the angle and gives the instrument a slight turn between his fingers, so as to bring the little pointed knife inward. He now presses the latter into the lower part of the sac containing the lens and draws it sharply upward with his fingers.

The result of this is to sever the envelope of the lens, and the liquid immediately begins to run out. A pressure of the finger on the outside of the eyeball then makes it come out at the top. That is all the surgery that constitutes the operation for cataract, divested of the multitude of scientific terms employed in the profession.

A natural question at this point is, "What takes the place of the lens? Doesn't it leave a hole in the eye?" The cavity in the eye occupied by the lens fills up with vitreous humor within less than three minutes after the removal of the lens. This substance is supplied to the eye in abundance by nature, and is being constantly replenished. The place in the eye that was occupied by the lens fills with this transparent substance, and the whole organ retains its original shape and form. The transparent film which had formerly been the envelope of the lens folds back out of the way of its own accord, leaving the field clear and unobstructed from the retina at the extreme back of the eye through the iris, the anterior chamber and the cornea. Thus the intervening obstruction formed by the affected lens, and called the cataract, has been removed and the eye can see with its former vigor and clearness.

## GRANULAR EFFERVESCENT PREPARATIONS.*

By AUGUSTUS BRADLEY.

THIS form of medication is a most pleasing one for the exhibition of many nauseous and disagreeable medicines and those remedies where the assistance of the sedative action of carbonic acid is desired.

Not many years ago the effervescent draught was considered indispensable, but at present it has comparatively fallen into an unmerited oblivion.

It is, however, again making its appearance in such localities where it is extensively advertised.

The efficacy of these preparations, as a class, depends principally upon the amount of available carbonic acid gas contained therein. The worthless (non-effervescent) stock upon our shelves, in main, prompted me to devise a scheme whereby they could be supplied by the pharmacist fresh on a short notice.

### MODE OF PREPARING.

I propose in this paper to relate a few experiments, with results, also giving methods and formulas, with an apparatus of my own get up, whereby the retail pharmacist can prepare his own granular effervescent preparations, and not be dependent upon the wholesale manufacturer as heretofore. These preparations are made by causing a mixture of powdered ingredients, consisting of sodium bicarbonate, tartaric or citric acids, sometimes both, and the medicament to become sufficiently moistened, as when in such pasty condition, rubbed through a coarse sieve and dried, granules are produced.

Each article should be separately powdered and dried before mixing, the citric acid to be added last and rubbed in quickly.

The drying apparatus should be previously heated for the reception of the moist granules. The proper pasty consistency of the mixture is only ascertained through practice, some mixtures requiring more of the moistening agent than others.

### SELECTION OF A MOISTENING AGENT.

The selection of a cheap moistening agent seems to me to be an item of great importance, especially when large quantities are to be made.

Samples are prepared with ether, amylic alcohol, chloroform, live steam, sirup, carbon disulphide, etc., but with each too great a loss of carbon dioxide resulted during manipulation to encourage the use of any.

Water or moisture being the prime cause of this loss, I concluded that if a liquid containing no water at all be used, granules could be made without any loss of gas.

I was aware that absolute alcohol contained practically no water, but also that, if it answered from this standpoint, its expensiveness would discourage its use. However, a small quantity of a mixture was tried, but owing to the hygroscopic properties of this alcohol, the experiment proved a failure. In a few minutes after the granules had been removed to be dried, decomposition took place, resulting in an adherence and puffing up of the granules, showing too great a loss of gas.

Purified benzin was next tried, but owing to the disagreeable taste, odor, and too easily crushed condition of the dried product, it was abandoned.

Benzin, with different percentages of absolute alcohol, resulted likewise.

After numerous experiments I found 95 per cent. (by volume) ethylic alcohol, as recommended by the National Formulary, to be the best agent for general use.

### SIEVES.

I use four copper wire sieves, Nos. 6, 20, 40 and 60, No. 6 to pass the pasty mass through the glass shelf, No. 20 to separate the dried granules from the dust (some manufacturers, to prevent any loss, do not separate it). Nos. 40 and 60 are used for thoroughly mixing the different ingredients.

I like the copper wire sieves the best, owing to their less liability of being attacked by corrosive agents.

The temperature of the drying apparatus, with but a few exceptions, should always be constant, taking care not to allow it to go above 158 degrees F., for fear of converting the sodium bicarbonate back into the carbonate, through the loss of carbon dioxide, and also the formation of caramel in those preparations containing sugar with tartaric acid.

### LOSS IN WEIGHT.

The loss in weight encountered in drying the following articles, as found in commerce, are:

Citric acid, 8 to 10 per cent.
Sodium bicarbonate, 2 to 3 per cent.
Tartaric acid, 1-500 per cent.

The use of tartaric acid alone, as recommended by the National Formulary, leaves the granules too soft. An addition of citric acid will give them firmness, and render their taste more acceptable to the majority of people.

There is no class of preparations that require such special care as these. The absence of moisture is absolutely essential; therefore the bottles should be thoroughly dried and hermetically sealed immediately after being filled. Those composed of iron, pepsin, and their compounds should be stored in amber or blue glass bottles.

I will submit a few formulas, which I have compiled and am using, most of which in course of preparation require some special precautions, which will, however, present themselves to the operator upon his first attempt:

1. GRANULAR EFFERVESCENT CAFFEINE CITRATE.

| | |
|---|---|
| Caffeine citrate | 20 grains |
| Sodium bicarbonate | 600 grains |
| Citric acid | 300 grains |
| Tartaric acid | 240 grains |
| Powdered sugar | 600 grains |

2. GRANULAR EFFERVESCENT CAFFEINE CITRATE AND PHENACETIN.

| | |
|---|---|
| Caffeine citrate | 20 grains |
| Phenacetin | 100 grains |
| Sodium bicarbonate | 600 grains |
| Citric acid | 300 grains |
| Tartaric acid | 240 grains |
| Powdered sugar | 620 grains |

3. GRANULAR EFFERVESCENT POTASSIUM BROMIDE.

| | |
|---|---|
| Potassium bromide | ½ troy oz. |
| Sodium bicarbonate | 3¾ troy oz. |
| Tartaric acid | 1¼ troy oz. |
| Citric acid | 2 troy oz. |

4. GRANULAR EFFERVESCENT CAFFEINE CITRATE AND POTASSIUM BROMIDE.

| | |
|---|---|
| Caffeine citrate | 50 grains |
| Potassium bromide | ½ troy oz. |
| Sodium bicarbonate | 3¾ troy oz. |
| Tartaric acid | 1¼ troy oz. |
| Citric acid | 2 troy oz. |

5. GRANULAR EFFERVESCENT MAGNESIUM SULPHATE.

| | |
|---|---|
| Dried magnesium sulphate | 400 grains |
| Tartaric acid | 300 grains |
| Citric acid | 240 grains |
| Powdered sugar | 460 grains |
| Sodium bicarbonate | 600 grains |

This is practically identical with the granular effervescent magnesium citrate on the market.

6. GRANULAR EFFERVESCENT VICHY SALT.

| | |
|---|---|
| Potassium bicarbonate | 45 grains |
| Sodium bicarbonate | 5 troy oz. |
| Magnesium sulphate | 45 grains |
| Sodium carbonate | 5 troy oz. |
| Tartaric acid | 1½ troy oz. |
| Citric acid | 2 troy oz. |

7. GRANULAR EFFERVESCENT PEPSIN.

| | |
|---|---|
| Pure powdered pepsin | 50 grains |
| Citric acid | 1¾ troy oz. |
| Tartaric acid | 1½ troy oz. |
| Powdered sugar | ½ troy oz. |
| Sodium bicarbonate | 3¾ troy oz. |

8. GRANULAR EFFERVESCENT PEPSIN AND BISMUTH.

| | |
|---|---|
| Pure powdered pepsin | 50 grains |
| Bismuth and ammonium citrate | 50 grains |
| Citric acid | 1¾ troy oz. |
| Tartaric acid | 1½ troy oz. |
| Powdered sugar | ½ troy oz. |
| Sodium bicarbonate | 3¾ troy oz. |

* From a paper read before the North Carolina Pharmaceutical Association.—*American Druggist.*

## TESTS OF TRANSPARENCY.

ACCORDING to a paper published in the *Journal fur Praktische Chemie*, the author has made some experiments upon the determination of the transparency of different media by means of Crookes' radiometer. With this object, he first investigated a method of ascertaining accurately the rate of rotation of the vanes of the radiometer. The instrument was inclosed for this purpose in a metal case, blackened on the inside, and open in the direction of the radiant rays. This case was provided with a side tube, through which the observer could see the vanes rotating. When a rotating vane came into a certain position with relation to the source of light and the eye of the observer, a flash of light was seen. By means of a chromascope, the instant at which this flash occurred was noted. A convenient number of transits of the vanes were observed and counted: and the time occupied was again determined by the aid of the chromascope. The method is susceptible of a considerable degree of accuracy; and it was first employed in experimentally testing the action of the radiometer when the instrument was first at a distance of 20 centimeters from the source of light, and secondly at twice the distance. In three successive experiments, the ratio of the numbers representing the revolutions of the vanes was found to be 3·95, 3·99, and 4, which is exceedingly near the theoretical value as given by the law of radiation. In endeavoring to measure the transparency or the diaphaneity of bodies, the author used a couple of radiometers exposed to the same source of light, and adjusted to revolve at the same rate of speed. The plate or solution to be examined was then introduced in front of one of them; and by readjusting the distances the rates of revolution could again be equalized. The diaphaneity of water being taken as unity, it was found in this way that saturated aqueous solutions exhibit only slight differences in diaphaneity. The addition of sodium chloride increased it by 3·75 per cent., while oxalic acid lowered it to 98·79 per cent.; but nothing else made so much difference. The diaphaneity of carbon bisulphide, 141·70, exceeds that of glass, which is 140·77; and it is noted that carbon tetrachloride, which has the index 145·77, is more diaphanous than air, which stands at 142·26 in the same scale.

## TABLE OF ATOMIC WEIGHTS, REVISED TO JANUARY 1, 1894.*

By F. W. CLARKE.

| Name. | Atomic weight. |
|---|---|
| Aluminum | 27·0 |
| Antimony | 120·0 |
| Arsenic | 75·0 |
| Barium | 137·43 |
| Bismuth | 208·9 |
| Boron | 11·0 |
| Bromine | 79·95 |
| Cadmium | 112·0 |
| Cæsium | 132·9 |
| Calcium | 40·0 |
| Carbon | 12·0 |
| Cerium | 140·2 |
| Chlorine | 35·45 |
| Chromium | 52·1 |
| Cobalt | 59·0 |
| Columbium | 94·0 |
| Copper | 63·6 |
| Erbium | 166·3 |
| Fluorine | 19·0 |
| Gadolinium | 156·1 |
| Gallium | 69·0 |
| Germanium | 72·3 |
| Glucinum | 9·0 |
| Gold | 197·3 |
| Hydrogen | 1·008 |
| Indium | 113·7 |
| Iodine | 126·85 |
| Iridium | 193·1 |
| Iron | 56·0 |
| Lanthanum | 138·2 |
| Lead | 206·95 |
| Lithium | 7·02 |
| Magnesium | 24·3 |
| Manganese | 55·0 |
| Mercury | 200·0 |
| Molybdenum | 96·0 |
| Neodymium | 140·5 |
| Nickel | 58·7 |
| Nitrogen | 14·03 |
| Osmium | 190·8 |
| Oxygen | 16·0 |
| Palladium | 106·6 |
| Phosphorus | 31·0 |
| Platinum | 195·0 |
| Potassium | 39·11 |
| Praseodymium | 143·5 |
| Rhodium | 103·0 |
| Rubidium | 85·5 |
| Ruthenium | 101·6 |
| Samarium | 150·0 |
| Scandium | 44·0 |
| Selenium | 79·0 |
| Silicon | 28·4 |
| Silver | 107·92 |
| Sodium | 23·05 |
| Strontium | 87·6 |
| Sulphur | 32·06 |
| Tantalum | 182·6 |
| Tellurium | 125·0 |
| Terbium | 160·0 |
| Thallium | 204·18 |
| Thorium | 232·6 |
| Thulium | 170·7 |
| Tin | 119·0 |
| Titanium | 48·0 |
| Tungsten | 184·0 |
| Uranium | 239·6 |
| Vanadium | 51·4 |
| Ytterbium | 173·0 |
| Yttrium | 89·1 |
| Zinc | 65·3 |
| Zirconium | 90·6 |

Oxygen=16 is taken as the base of the system, but for provisional reasons only. Before long, with improved determinations, it may be practicable to return to the more philosophical H=1, when the entire system can be transformed once for all into something like permanent shape. A premature transformation of this kind, however, would only work confusion, without corresponding benefit.

## SODIUM PEROXIDE.

FURTHER interesting properties of sodium oxide are described in the current *Berichte* by Prof. Poleck, of Breslau. It is shown that sodium peroxide rapidly reduces salts of gold, silver and mercury, with separation of the metal and evolution of oxygen gas. Platinum, however, is not precipitated from chloroplatinic acid or chloroplatinates until they are decomposed with silver salt, when reduction both of the resulting platinum chloride and of the silver chloride occurs, both metals being precipitated. Ferric hydroxide is precipitated, as might be expected, from both ferrous and ferric salts; from manganous salts manganese dioxide is precipitated, presumably hydrated; and from salts of cobalt, the higher cobaltic oxide. Permanganates are reduced to manganese dioxide, but chromic oxide is oxidized to chromic acid. The separation and quantitative estimation of iron and chromium or manganese and chromium are easily achieved by utilizing these reactions, for iron is precipitated as ferric hydroxide and manganese as peroxide, while chromium remains in solution as chromate of sodium. Sodium peroxide also produces the highly oxidized sodium peruranate, $Na_4U_2O_8+8H_2O$, directly from salts of uranium, and it may readily be isolated by addition of alcohol, which precipitates it. It is also interesting that iodine is oxidized on warming directly to the difficultly soluble acid sodium periodate, and upon decomposition of this salt with silver nitrate the normal silver periodate is at once produced, and free periodic acid $HIO_4+2H_2O$ may be readily obtained from it in large crystals by decomposition with bromide and sub-

* From the report of the committee on determinations of atomic weight published during 1893.—*Journal of the American Chemical Society.*

THE VISIT OF MILTON TO GALILEO AT THE VILLA D'ARCETRI, NEAR FLORENCE, IN 1638. *From the Graphic, London.*

sequent evaporation *in vacuo*. Potassium ferricyanide behaves toward sodium peroxide in a similar manner to its action with hydrogen peroxide, reducing it energetically to ferrocyanide, and the volumetric process of Kassner can be readily carried out by use of it. Sodium peroxide reacts with lead oxide in presence of water to produce a plumbate of sodium of the composition $Na_2PbO_3+4H_2O$. Organic compounds dissolved in alcohol are usually very rapidly oxidized by sodium peroxide, while the alcohol itself is not attacked. Ether, on the contrary, at once ignites when brought in contact with the peroxide.

## MILTON'S VISIT TO GALILEO.

IN 1638 Milton, then in his thirtieth year, commenced his famous continental journey. Hurrying through France, which to him presented little interest, he reached Florence, the ultimate object of his journey, early in August of the same year. In the environs of this city was then living Galileo, the great Italian philosopher and astronomer, in the Villa d'Arcetri, where the last years of his life were spent. Galileo was then in his seventy-fourth year and had within a few months become totally blind. His eyesight, however, was the only sense affected by age, and he still found a pleasure in explaining his theories and reciting his poems to travelers who came to pay homage to his learning. After all the persecution which he had undergone, Galileo had then been allowed to return to Tuscany, but under certain conditions and restrictions imposed by the Holy Office, which made him nominally a prisoner. So until his death, in 1641, he lived in the Villa d'Arcetri, and it was here that Milton saw him—old, frail, and blind, through still vigorous in intellect, and keenly enjoying the society of the young men.—*The Graphic, London.*

## THE RECENT EGYPTIAN DISCOVERIES.

IN our last SUPPLEMENT, 964, page 15410, we gave a number of illustrations of the recently discovered remains of the pyramids of Dahshur, and we now present some additional views pertaining to the same subject. The reader is referred to the above article for descriptions of the present engravings, which are from *L'Illustration.*

The following is from the *London Times.*

Every season brings more and more spoil of the Egyptians, and it is always the unexpected that we must expect. A private tomb gave up the Kings of Thebes; the vaults of a priestess of Hathor were found filled with mummies of priests of Amen. Priceless scraps of literature have been recovered from cheap *papier-mache* coffins, and farm accounts have been known to bear a lost poet on their reverse. The latest surprise is that, in a Memphite tomb, rifled ages ago, hard by a pyramid, supposed to be of the 6th Dynasty, has been discovered a royal treasure of the twelfth.

The pyramids of Dahshur rise on the left as one rides to the Memphite necropolis at Sakhara, the nearer one being a formless mass of brickwork, almost cut in half by treasure seekers, and buried deep in drift. No royal chamber has ever been found in it, and M. De Morgan, the present Director-General of the Service of Antiquities, conceived the idea that it might be only an enormous *mastaba*, built above the royal tomb. He began, therefore, in February last to dig about its roots in the hope of hitting the mouth of the shaft by which the burial must have been introduced from outside. The desert all round the pyramid base was found full of tombs, square-bricked shafts descending from ruined *mastabas* to the grave chambers. All had been rifled, and nothing of interest resulted at first but sculptured slabs and *stelæ* from the *mastabas*, and canopic jars and chests. From the foot of one shaft, 30 ft. deep, a winding passage, roughly hacked, was found leading into the bowels of the rock. Groping on, the explorers debouched into a vault, nearly filled by a fine sarcophagus inscribed with the name of Nefert-Heut, a queen. Alas! it was broken and empty, rifled by the same hands that had cut the passage. A door, however, led into another gallery—in this case no thieves' work, but an original part of the tomb. It was straight for a long distance, chambers opening on the left, each with rifled sarcophagi and canopic chests. The farthest group of vaults yielded the name of a princess, Seut-seubetes, but was apparently as empty as all the rest. M. De Morgan, like Schliemann, is not content till he has reached rock, and therefore set his men to pick over the floors, expecting no reward beyond the credit of clearing a fine tomb, structurally interesting, though completely void. In the floor of a passage in the group of chambers belonging to the princess the picks encountered a patch of soft earth. A few inches lower the remains of a silver-encrusted box were disclosed, and piece by piece below its crumbling lid was found the first installment of the treasure of Dahshur. A long necklace of amethyst beads, a second of amethyst, turquoise, carnelian, *lapis lazuli* and gold, a kohl pencil in exquisite gold bead work, a bunch of gold rose petals, three finely cut scarabæi, the gold face of one bearing the royal name of Usertasen III., couchant lions, and other tiny pieces in gold—these were all admirable, but eclipsed by two objects in mosaic work—namely, a pendant or brooch shaped like a lotus and set with *lapis* and carnelian, and a royal pectoral, on which two crowned hawks support the cartouche of Usertasen II. The plumage is in stripes of *lapis* and turquoise, the symbols of the royal name in these and carnelian; the whole is set in gold and worked on the reverse to represent the same scene as the front. Whether for purity of design, exquisite coloring, or absolute finish, it equals any piece of jewelry in existence. It would be a *chef d'œuvre* of the goldsmith's art of to-day; made 4,500 years ago, it is a miracle.

A few yards further along the passage was found a second box hidden like the first. Two large pectorals were in it. On the first, two figures of Amenemhat III. smite the Asiatics; the design is crowded and less pleasing than the pectoral of Usertasen II., though the mosaic of stones and gold is not less finely fashioned. On the third pectoral two hawk-headed apes beneath the cartouche of Usertasen III. trample on prostrate men. Nothing for sheer finish excels this

THE PYRAMID OF DAHSHUR.

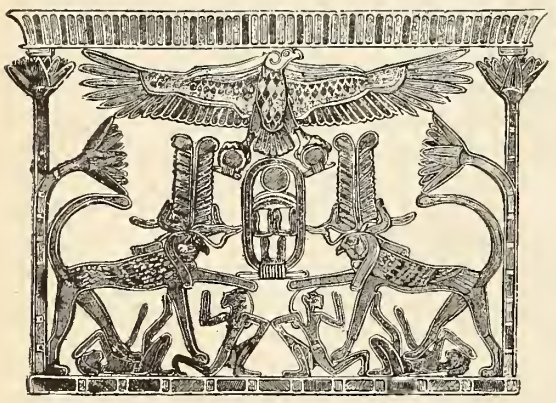
THE EXCAVATIONS OF DAHSHUR.

piece in the whole treasure. For the rest we can only give a catalogue of the most beautiful contents of the box. There were large cowrie shells of gold, pestle and mortar in gold and *lapis*, rings with beautifully graven *chatons*, necklaces of amethyst and carnelian, large rose petals—one with a wonderful mosaic center—mirrors with gold handles, gold lion masks, and a second kohl pencil adorned with a pattern of gold beads, soldered on one by one, a marvel of delicate work. There is not a single object in the treasure not remarkable; the whole can be fitly compared only to Schliemann's find in the circle graves at Mycenæ.

Why were these treasure coffers so hidden, and who hid them? Perhaps the legitimate owners, fearing spoliation; perhaps robbers waiting for a favorable moment to carry them away. So cunningly concealed were they that the chief wonder is how they were ever found at all; and M. De Morgan's discovery of them will assuredly rank among the most remarkable successes in the records of explorations. He is digging still for the royal chamber, but up to the present moment the pyramid has preserved its secret inviolate.*

The most considerable excavation carried out during the past season in Egypt has been that of the Exploration Fund in the temple of Queen Hatasu, at Deir el Bahari, near Thebes. If M. De Morgan has revealed a treasure, M. Naville is bringing to light a temple. The unique pile of buildings which the queen erected and adorned to serve as funerary shrine for her father, her husbands, and herself, has been almost entirely buried for ages beneath earth slips and the *débris* of a Coptic convent. Thirty years ago Mariette laid bare a small portion, and enriched the world with the famous wall pictures of the queen's naval expedition to the land of Punt, but the rest was left under mountains of rubbish till last season. Thanks to the Egypt Exploration Fund, the whole of this beautiful monument of the greatest period of the empire is now in process of being exhumed and restored. It is built on three terraces; the upper was cleared almost entirely last season, and among other things a unique high altar was laid bare, and a side of a magnificent ebony shrine of Thothmes II. discovered. The latter is now mounted between glass at Ghizeh, and is the finest piece of ancient woodwork in the collection.

Both this season and the last many hundreds of blocks have been recovered, sculptured with the Queen's exploits, her wars and the transportation of her obelisks from Syene. So long buried, the coloring of these scenes is as vivid as their execution is admirable, and they will bear comparison with any work of the 18th and 19th Dynasties, even that of Seti I. at Abydos. During the past winter the middle terrace also has been cleared in great part. A fine colonnade, a hypostyle hall with brilliant paintings and a portico adorned with scenes relating to the Queen's birth have been opened once more to the light of day. The portico reliefs have a peculiar interest as being apparently originals of the famous scenes in the temple of Amenhotep III. at Luxor, in which his birth by an immortal father is portrayed. In clearing so large a space many small things must always be found, and in this instance there has been a large find of *ostraka*, hieratic, demotic and Coptic, of blue scarabs and amulets of the famous local ware. The work is to be resumed next season, and when all is done the Egypt Exploration Fund will have the credit of having restored to the world one of the most singular and beautiful monuments of antiquity.



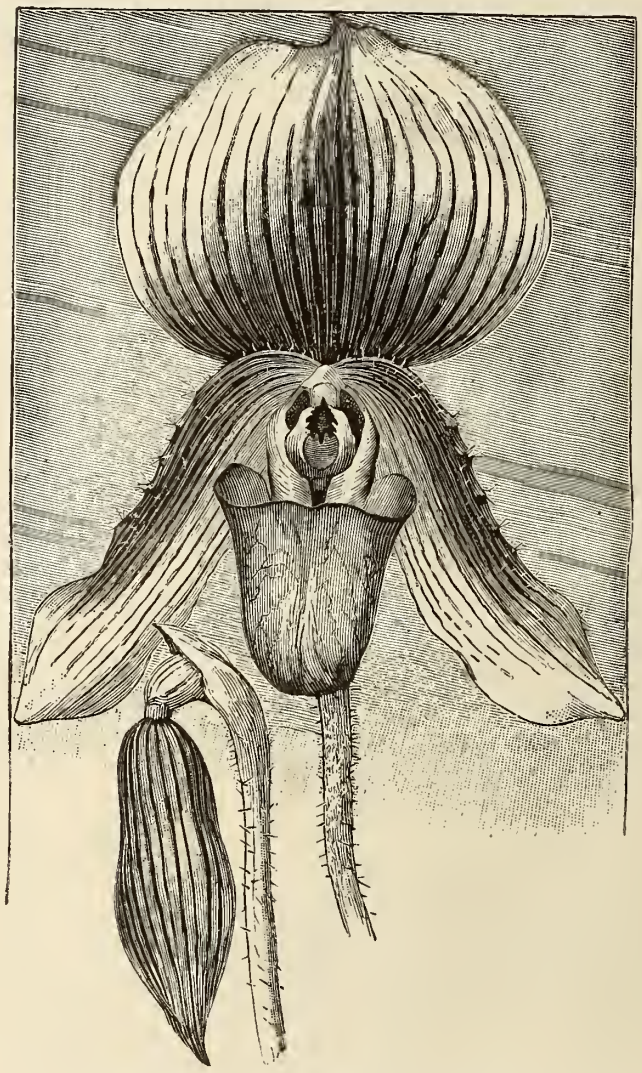
BREASTPLATE OF USERTASEN III

Thirty miles lower down the river Mr. Flinders Petrie has met with his usual success at Kuft, the site of ancient Coptos. His marvelous instinct of discovery led him to select the temple site, which lies in the midst of the Roman city, and, turning over the *debris* from end to end, he has found most interesting remains of the worship of Khem in all periods. In the foundation sand of the Ptolemaic restoration he lighted on three *colossi* of the god, so strange and rude in style that he supposes them to be almost prehistoric, the work of the first immigrants from Arabia before Mena founded the 1st Dynasty. Carved on them in low relief are symbols, shells and animals, whose style may help to fix their period. A lively discussion is likely to arise, and we may expect to hear them referred to every date from that of the Arabian immigration to the occupation of Coptos by the Blemmyes after our era. Other finds of Mr. Petrie's, however, go back far enough; a fragment of alabaster bore the cartouche of Khufu of the 4th Dynasty, and slabs of a pavement of Thothmes III. showed on their reverse sides scenes from the temple of the 11th Dynasty, unfortunately very imperfect, for they are the earliest temple sculptures known. A door jamb was carved with the finest work of Usertasen I. of the 12th Dynasty. Foundation deposits of the 18th, a triad and *stelæ* of the Ramesside period, pottery of all the dynasties from before the pyramid builders to the Roman, make up with many odds and ends a find equal in interest to any that Mr. Petrie has ever made, except, perhaps, at Naucratis. We may mention also that a remarkable Roman inscription was found at Kuft shortly before Mr. Petrie's arrival, giving a list of tolls to be paid at the Red Sea gate of Coptos.

A very important symptom of the past season has been the awakening of interest in ancient Alexandria, and we shall probably hear a great deal about the Ptolemaic and Roman capital in the future. It is the most unexplored site in Egypt, and it is really astounding that we should know so little of what was once the first city (and has always been among the first) on the Mediterranean. The meeting place of so many races, bound up with Jewish and early Christian history, an unrivaled center of culture, the burial place of the greatest of ancient conquerors and of a long line of his successors, the most singular and favored city in the Roman empire, Alexandria has limitless possibilities. The ancient city lies deep under the modern; but, now that the municipality is favorable, the new museum has been organized, and persons of local influence are at work, we may hope that an exploration has been begun which will prove of extraordinary interest, if carried through.

Odds and ends of work there have been many. The beautiful temple of Kom Ombo has been rescued by M. De Morgan from the wash of the Nile, and albeit a little too thoroughly swept and garnished, presents a very fine appearance. Members of the French mission have copied its inscriptions throughout, and the plates will appear shortly in the publication of "Unedited Monuments," promoted by the Director-General. Mr. Sayce has been exploring Nubia and finding forts and *graffiti* and *stelæ*, whereof he has given account in the pages of the *Academy*. Dr. Hess has been searching the same shores for demotic texts, but the result of his labors is not known. Captain Lyons, R.E., has brought back much information and some antiquities of note from the Oases, and Mr. Bloundell is about to explore the Temple of Ammon at Siwah in the course of a wild and difficult journey which he hopes to terminate in the Cyrenaica. Messrs. Tyler and Somers Clarke are continuing their work at El Kab.

* The total number of pieces in gold found in this tomb was 165, besides 240 beads of amethyst, 70 beads of emerald, *lapis lazuli*, and carnelian, and a larger number of smaller beads of various precious stones. The total weight of gold pieces found was 314½ grammes.



CYPRIPEDIUM CALLOSUM SANDERÆ.

## CYPRIPEDIUM CALLOSUM SANDERÆ.

A MOST interesting and valuable novelty, being the nearest approach to an albino yet found of this species. The habit and size of flower is identical with the type, but the color is vastly different. The large, broad dorsal sepal is of the purest white, beautifully lined and veined with lovely emerald green. The curved petals have a ground color of pale yellowish green, the lower halves (horizontally) and also the apices are pure white. The lip is apple green, large and pointed; the flower stands up well. F.C.C., R.H.S., May 23. Messrs. F. Sander & Co.—*The Gardeners' Magazine.*

## LICORICE.

(*Glycyrrhiza glabra*, L.)

IN consequence of the large quantities of licorice root now exported from Asia Minor and other licorice-growing countries to America, where it is used in the preparation of tobacco for chewing purposes, and also in making a fancy drink, a considerable amount of attention has been given to the introduction of the plant in India, America, and other countries where it is at all likely to thrive.

The licorice plant (*Glycyrrhiza glabra*, L.) is a native of North Africa, Southern Europe, Syria, Persia, and Afghanistan, and is cultivated in France, Russia, Germany, Spain, and China, and also to a slight extent in England, where its growth is said to date from the middle of the sixteenth century. Some twenty or thirty years ago licorice was cultivated in market gardens in the neighborhood of London, especially about Kew and Isleworth, and more recently at Mitcham. At the present time Yorkshire produces the larger quantity of English-grown root, and the principal seat of its culture is in and around Pontefract. Its cultivation in this particular neighborhood dates back several generations, the deep, rich, loamy soil which occurs here being specially suited to the growth of the plant. The bulk of the licorice gardens are situated on the fertile slopes east and northeast of the town, the country between Pontefract and Knottingly being largely occupied by market gardens, in which licorice forms an extensive crop. The following notes on the cultivation of the plant and harvesting the root are taken from an article on the "Culture and Preparation of Licorice," which appeared in the *Leisure Hour* for April, 1893:

"The plants are grown in rows, and they stand from three to four years before arriving at perfection. The three years' growth is thinner and scarcely so rich in juice as the four years' plants. Occasionally, if the market is flat, the plants are allowed to grow a fifth season, but the root becomes thicker, coarser, and more woody. The long, straight root goes down to a great depth, averaging perhaps about four feet, but sometimes even to six feet, and as the soil has to be dug down to this depth by hand to extract the root, the labor of cropping or harvesting is considerable. During the first two years that the land is occupied by licorice, the plants themselves being small allow of other crops being planted between the rows, and potatoes, and different varieties of cabbage, are mostly grown. The ground being earthed up around the licorice plants, the furrows thus made afford much protection to the vegetable crops, and, as the ground is always richly manured before planting licorice, favorable conditions are thus insured for the production of early and very superior vegetables; indeed, it is said that the vegetable crops from a licorice plantation always command high prices in the Leeds markets. After the second year, however, the licorice plants grow to such a height, and spread their foliage so widely, that other crops will not grow beneath them. On a visit to Pontefract, namely, in the early part of September, the writer saw some of these licorice gardens where the plants had attained the age of five years and a height of about four feet, each plant sending up numerous straight stout stems from the root-stock or crown, each stem bearing large spreading alternate leaves, composed of a number of opposite leaflets of a bright green color.

"The harvesting season is about the middle of September, and after the roots have been taken out of the ground by hand digging, as before mentioned, they are stored in cool ventilated houses or cellars, usually in sand, until a favorable opportunity occurs for the process of dressing, which consists of trimming off all the fibrous rootlets, buds, and runners, or stolons. The fibrous roots are ground into licorice powder, which is used as a medicine, and the buds and runners are carefully preserved in sand for planting, for it is from these alone that new plants are raised, and never from seed. The plants never being allowed to flower, do not, of course, produced seed. Flowering would deteriorate the value of the plant from a commercial point of

view, as the juices would be consumed in perfecting the flowers, and the roots thus become useless. The planting of buds and runners for a new crop is done in the early part of April."

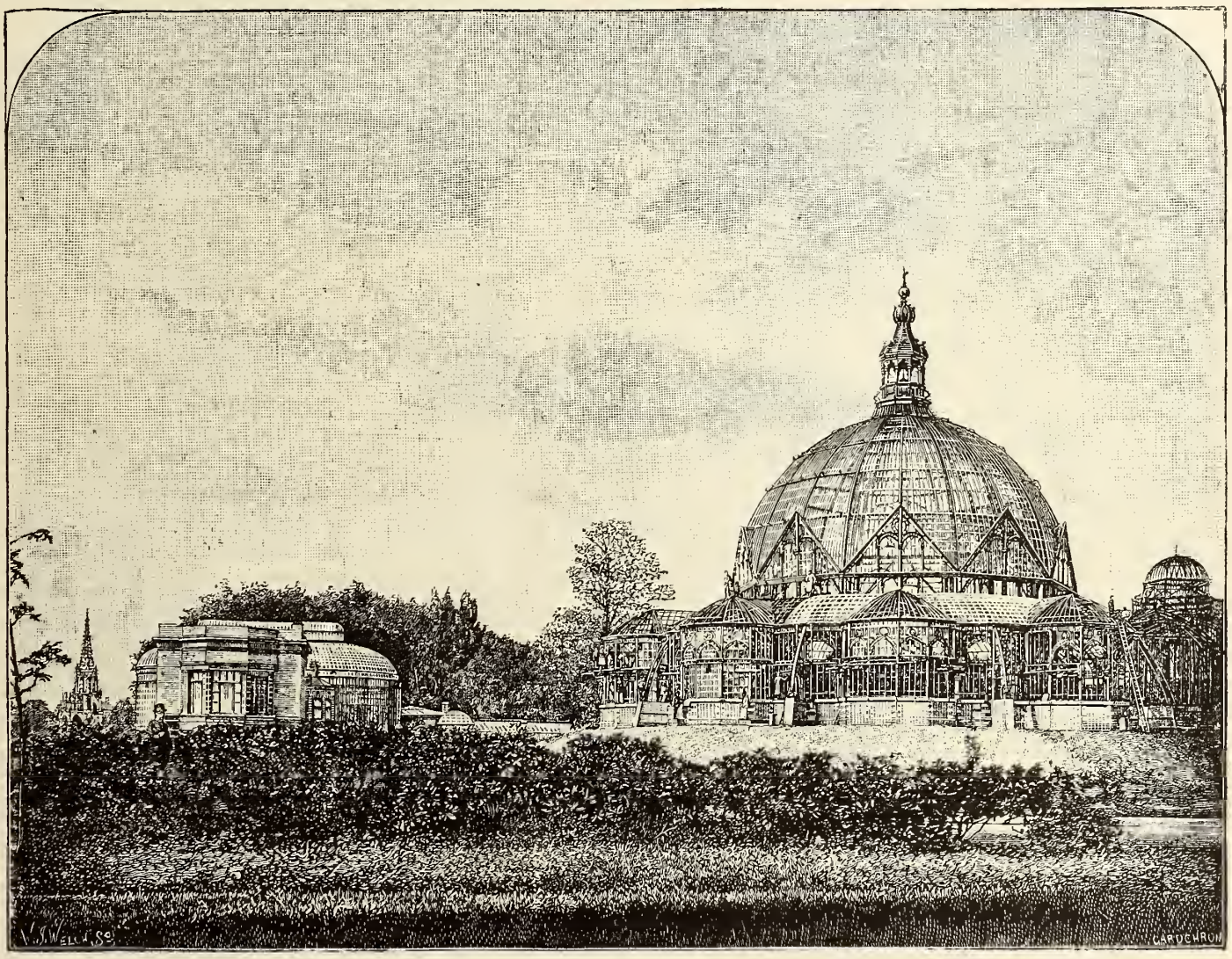
In Bentley and Trimen's *Medicinal Plants*, vol. ii., under plate 74, it is stated that "both Spanish and Russian licorice roots are usually imported in bales or bundles, or, rarely, in the case of that portion of the Spanish variety which is derived from Alicante, loose or in bags. The Spanish licorice root is in straight, unpeeled pieces, several feet in length, and varying in thickness from a quarter of an inch to about one inch. That from Alicante is frequently untrimmed and dirty in appearance, but that from Tortosa is usually clean and brighter looking. The Russian licorice root, which is imported from Hamburg, is either peeled or unpeeled. It is in pieces varying from twelve to eighteen inches in length, and from a quarter of an inch to an inch or more in diameter. Combined with the usual sweetness of licorice root, this variety has a feebly bitter taste."—*Kew Bulletin.*

## CONSERVATORY CHAPEL AT LAEKEN.

IN the grounds of the Palace of His Majesty the King of the Belgians, on high ground, with the lake beneath, and with the opposite bank richly clad with flowering shrubs, capped by the picturesque old windmill, which visiting artists always admire, stands the recently finished conservatory chapel, planned by His Majesty, and which, while being a novelty in its way, is a beautiful one. Wholly built of glass and ornamental iron-work, it is externally, and by its arrangement internally, in the nature of a gigantic conservatory, the only evidence of its being consecrated to divine service being the altar piece, which faces the entrance, and a few other less conspicuous objects. The width from the entrance to the altar on the opposite side is about 140 feet; the height of the dome 100 feet. The space beneath the dome has a mosaic floor, on which chairs are placed, leaving a walk up the middle. The dome is supported by ten pairs of polished red granite pillars on white pediments, and around each pair a space is laid out with tile edging, in which tall palms and tree ferns are planted, faced by flowering plants, which are removed as they go out of bloom, and are replaced by others in flower. Around the space beneath the dome is a circular walk, 20 feet in width, and beneath which the pipes for heating the structure are laid. On the outer side of the walk, and bordering the building, provision is made all around for palms and flowers, and lofty alcoves are arranged, in the front of each of which a white marble statue is placed, the alcove behind being filled with lofty palms and other foliage and flowering plants, some of which are permanent, and the others removable. It is altogether a beautiful structure, and artistically arranged, and one in which the hand of time will evolve still greater beauties, as the plants grow and adapt themselves to the positions in which they are placed. It is scarcely necessary to say that it is lighted by electric light, in the same way as the miles of the flower-planted corridors which connect all the conservatory-like buildings, in which state functions are held, the great palm houses, the orangery, etc.

Descending the steps at the side, and under the guidance of Mr. Knight, who has charge of the vast domain, we proceed to note a few of the more striking features in the gardens as we pass. On the steps are vases filled with flowering plants, and on the roof the flowers of varieties of Tropæolum Lobbianum and of Pelargonium peltatum. At the bottom is a fine group, in which the center consisted at the time we write about of a grand plant of Cattelya Trianæi, with about sixty open flowers. Passing along the corridor, we remark the numerous plants of the useful Coronilla glauca, which are trained over the roof, and which it is intended to plant more extensively. Arriving at the first tropical house, filled with giant Pandanus, Pritchardia pacifica, and other species of palms, tree ferns, Bromeliads, and many large baskets suspended from the roof filled with grand plants of Goniophlebium subauriculatum, with fronds ten to twelve feet long, we continue along the corridors, the principal plants in flower in which were quantites of Clianthus puniceus, Tacsonias, and other climbers, and then we come to the great azalea house, a blaze of bloom in the season, with the flowers of the fine specimens of Azalea indica varieties, but brightened by the soft yellow, salmon, and red tints of the Azalea mollis, and the fragrant mignonette, which is grown remarkably well at Laeken. Continuing along the corridors, in this part brilliant with the bright trusses of some of the scarlet pelargoniums, which adapt themselves for training, we come to the orchid houses, where only showy species are grown, useful for cutting or decoration. In the next stretch of covered way the fuchsias depending from the roof and clothing the sides are very effective, and the heliotropes both pretty and fragrant. Here, too, Brugmansia sanguinea is covered with large flowers.

Descending the steps to reach the tunnel, here necessary to cross the roadway, we remark the fine effect of the standard Polygalas and Genistas. The board steps leading to the fine winter garden, palm house, and orangery, often alluded to in these pages, have a very pretty show of flowers, among which were some very effective orchids. Overhead were suspended large masses of Oncidium pulvinatum, with their long, pendent sprays of yellow flowers. Around the great palm house the planted out specimens of Euphorbia jacquinæflora are perfectly charming, arching their pretty sprays of vermilion flowers over the side of the walk, each plant having twenty to thirty sprays, some of them with nearly two feet length of flower at their tips. Vases of Cattleyas and Cypripediums, too, give bright color, and the fine old palms are indescribably stately and picturesque in this gigantic structure, whose dome, supported by enormous white pillars, is about 140 feet in height. The orangery, with its rows of huge specimens, beautiful in the subdued light; the magnificent camellia house, filled with flowers; and the good show of greenhouse rhododendrons, were in that perfect order in which Mr. Knight keeps everything in this great garden. His office is no sinecure, for some hundred and forty regular men are employed under him, and the extent of the work under glass alone may be estimated when it said that in a single year over £3,000 has been spent in fuel to heat the structures alone.—*The Gardeners' Chronicle.*



THE CONSERVATORY CHAPEL AT LAEKEN.

THE Spanish peasant works every day and dances half the night, and yet eats only his black bread, onion and watermelon. The Smyrna porter eats only a little fruit and some olives, yet he carries with ease his load of two hundred pounds.

## THE GEOLOGICAL DEVELOPMENT OF THE UNITED STATES.

By RALPH S. TARR.

A STUDY of the fossils, and of the rocks themselves, has given geologists a basis for a chronology; and the history of the earth is, therefore, divided into periods which do not mean periods of time, but periods in the life history of the planet. Thus the Archean does not represent a period of years, but a period including those rocks which were laid down before the oldest known fossiliferous rocks. The Paleozoic, divided into Cimbrian, Silurian, Devonian and Carboniferous, includes fossiliferous rocks which have certain definite fossils; and coming down toward the present, we have the Jura-Trias and Cretaceous as divisions of the Mesozoic, and Tertiary and Quaternary as divisions of the Cenozoic. Different text books adopt different names, but these are the ones used in this article. They cover a time incalculably long, amounting probably to millions of years; and from their pages the geologist is able to read a story with here and there a missing page, but with a sufficiently continuous record to enable him to place a correct interpretation upon the events of most importance in the history of the earth.

What the conditions were in this country during the earliest ages is only partly known. We believe that the planet was once a part of a nebula, and that it has assumed its present form by loss of heat and consequent solidification. Indeed, many of the changes of the past and present are apparently due to the continued loss of heat and contraction of a globe still hot within. The earth must have first of all become liquid and then solid. We have no determined signs of the original crust of the earth, though some hold that the rocks of Archean age, the granitic gneisses of Canada and New England, are a part of this original crust. If this be the case, we have not yet learned to discover from these rocks any facts concerning the early history of the globe.

When we come down to the beginning of the Paleozoic, the time when the first well defined signs of life appear in the rocks, our history is more perfect. Just as the history of man becomes more and more obscure as we go backward from the present, so the history of the earth is more dimly recorded in early ages than at present. We have not yet learned whether life existed on the earth before the Paleozoic. Some have argued that the presence of graphite, phosphate deposits, limestone and iron, are of themselves proofs that there were organisms in the Archean. These are not, however, necessarily proofs of this, but are mere suggestions; for all of these may have been formed in a different way. Supposed evidences of fossils have been recorded from these rocks, some of them being apparently valid, others without foundation. To my mind, the strong argument in favor of the existence of Archean life is the fact that at the beginning of the Paleozoic there appears in the rocks a great assemblage of fossil forms. Ever since then these forms have been widening in development, and it seems fair to believe that they had done so before the Paleozoic. Still, the Archean reveals to us no definite evidence of organic life in variety. It is true that such signs would hardly be expected in these old rocks, which have been so altered that even their original character is masked, and from which it would seem

probable that all delicate organisms would be removed.

Concerning the physical geography of the Archean times in this country, we have a little more knowledge. The continent of North America seems to have been thus early outlined. There was in Canada a great land area, probably rising in mountainous heights, the remnants of which are seen in Labrador, central Canada and northern Canada. Along the present site of our western Cordilleras there appears to have been an archipelago, the Canadian land extended into the United States near Lake Superior, and there was an area extending from New England southwestward, along the eastern flank of the present Appalachians, down into the Southern States. The Adirondacks formed a land area, perhaps an island. How far eastward into the Atlantic this eastern mountain area extended we cannot say, but it certainly extended some distance. Nor are we able to estimate the height of the mountains; but all things appear to indicate that they were very high.

Where now is located the central plain of the United States, that is the Mississippi Valley, there was a great inland sea; but its shore lines are not traceable in all places. It impinged upon parts of the Cordilleran Archipelago, the Canadian Highlands, the Adirondacks and the Highlands of New Jersey. Connecting these points, it seems probable that we would have a rough idea of the shape of the inland sea; but the form and extent of the inclosing land areas may only be guessed. One fact brought out in several places is that there was a soil on the Archean land, derived from the disintegration of the rocks, just as is the case at present in the Southern States and in most southerly temperate and tropical latitudes. We are not without indication also that there was abundant volcanic activity in Archean times. The conditions, therefore, appear to have been in many respects like the present, although the physical geography was very different.

Along the margin of this land the early Paleozoic sediments, the Cambrian, were accumulated. The two great depressions of the land to-day, the Mississippi and the St. Lawrence valleys, were submerged, having their present condition thus early outlined, just as the present highlands were then outlined. In the mountains of the East, early Paleozoic eruptions occurred and volcanoes existed in many places, among others near Boston and in Maryland. We find to-day the lavas that flowed out in those times, and the volcanic ash that was thrown into the air. The volcanic cones have long since wasted away, as indeed have the very mountains themselves, and we have only here and there fragmentary records of these early Paleozoic volcanic episodes.

During nearly all of the Paleozoic, that is, through the long ages of the Cambrian, the Silurian, the Devonian and a part of the Carboniferous, the interior sea maintained its existence and was the gathering ground for the waste from the inclosing mountainous lands. Many thousands of feet of rocks, sandstones, shales, conglomerates and limestones were deposited in this sea, which slowly subsided as the sediments accumulated. Here were then formed the stores of building stones which we are now using, just as similar rocks are forming in existing oceans. For the gathering together of these quantities of rocks ages to be measured in hundreds of thousands of years must have elapsed.

Where now the Appalachians are situated there was then a shore line with a land area extending eastward beyond the present coast line. Large rivers entered the Mississippi sea, adding to the ocean bottom the sediments which they bore. The climate was then more equable than now, and there existed in favorable places, just as in the Bermudas of to-day, reefs of coral, which are now fossilized in some of the limestone beds. A warm current appears to have circulated in this interior sea, and different geologists have postulated a great Sargassum Sea in the swirl of this current. In this way attempts have been made to account for the bituminous shales of Kentucky, and also for the zinc-lead deposits of Missouri and neighboring States, the idea being that the constant decay of the floating seaweed in one case furnished carbonaceous matter, in the other disseminated lead and zinc, which were later gathered together just as flint in chalk is gathered into nodules, from a disseminated state, by a process of segregation or concretion.

Toward the close of the Paleozoic, that is in the Carboniferous time, the beginning of the Appalachians and central plains was made by an elevation, which transformed this part of the inland sea into a shallow water and marshy land. Here the coal vegetation grew, and we owe to this condition the supply of fuel upon which we are now depending. The conditions at this time were very peculiar, but we cannot at this time enter into their consideration. Suffice it to state that a luxuriant vegetation, resembling the present tropical flora, in many characteristics, grew upon a swampy land, perhaps upon a salt water swamp. The temperature was more equable than now, the moisture apparently greater and the land in an unstable condition. The latter point is indicated by the fact that coal beds were formed and then covered with marine sediments, upon which other coal-producing forests were accumulated. That is, there was an alternation of land and ocean several times repeated.

Immediately following this condition, which may be considered a premonition of what was to follow, came the formation of the Appalachian in the Permian period and the formation of the plains of the central States. Since that time these areas have been dry land continuously and the eastern part of the country was practically finished except for slight additions to the east coast and extensive erosion and sculpturing of the land areas into the present hills and valleys.

Elsewhere in the United States the Permian appears to have been a period of dryness. In at least one place, Texas, and perhaps elsewhere, as in Kansas, there existed in this period a condition of interior salt seas which eventually became dead seas. The red beds of central Texas, with their accompanying deposits of salt and gypsum, were formed during this time.

In the next period, which we may call the Jura-Trias, combining two periods, as recognized in Europe, there came in the East the last period of volcanic activity, while in the West the Sierra Nevadas were formed into high mountains. The volcanic activity of the East was expressed along the entire Atlantic seaboard, from the Carolinas to Nova Scotia, by a series of intensions of a black trap rock and by volcanoes from which the same black basaltic lava flowed in great sheets. These intruded and extruded lavas still exist in remnants, and where they occur have produced striking features in the present topography. Among the more striking instances of this are the Palisades of the Hudson, the trap hills of Paterson and Orange, New Jersey, East and West Rocks of New Haven, Connecticut, Mts. Holyoke, Tom, the Hanging Hills of Meriden, and other prominent hills of the Connecticut Valley, etc. Since then there has been no volcanic action in the East. During the Jura-Trias there was an estuary where now the Connecticut Valley is situated and ocean waters extended as far northward as Northfield, Mass. The Atlantic coast was farther west than now and the waters of the ocean nearly bathed the eastern foot of the Appalachians.

During the Cretaceous period, which followed, the eastern coast of the country seems to have been nearly of the present form, although many of the finishing touches were wanting; but the western part of the country was very different from the present. A great arm of the sea extended, along the site of the present Rockies and the plateau of their eastern base, from the Gulf far northward into Canada. At times, and perhaps always during this period, there existed islands in this sea, but the main feature was that of water. Neither the Rockies nor the Coast Ranges existed then, and the Sierra Nevadas were bathed upon both their eastern and western bases by oceanic waters. Florida, Arkansas, Alabama and Texas were mostly beneath water, and here the sediments that were later built into these lands were accumulated.

At the close of the Cretaceous, much of this area was permanently transformed into land and the Rockies began to be formed. There was added to the east coast a strip of land, widening toward the south, and at present forming the inner or western part of the plains which lie between the Appalachians and the ocean. Florida was not formed and the low swampy plains from New Jersey southward were still beneath the ocean. An arm of the sea extended up the Mississippi Valley and the site of the Rocky Mountains and the present interior basin was occupied by a land dotted by many very large fresh water lakes.

The Tertiary period witnessed many interesting changes, which, being recent, are much more plainly recorded than those of earlier periods. In the East the land was much higher than the present. There are indications, in the existence of apparent river channels on the ocean bottom, that the coast line was then at the edge of the continental shelf, or from 75 to 100 miles farther seaward in our latitude. During the Tertiary, portions of the coastal plains were added to the east coast and Florida was formed partly by elevation and partly by the outward growth of the land, through the agency of reef-building corals.

The most stupendous event of this period, however, was the development of the Rocky Mountains. By these rock folds great lakes were destroyed and their sediments incorporated into the growing mountains, and other lake basins were formed, some of which have been destroyed and others of which remain. Most of these, owing to the aridity of the climate, are either dry, as in the case of the great continental basin, or are occupied by salt lakes, such as the Great Salt Lake. Immense flows of lava, destructive volcanoes, and intrusions of igneous rock accompanied this folding and faulting of the rocks, and we find in the West no more common phenomenon than that of partially destroyed volcanic cones and lava flows. They exist throughout the entire Cordilleras, from the eastern flank of the Rockies to the Pacific and from the Mexican boundary to Canada.

As a result of these changes we owe the formation of the wonderful mineral deposits of the West, while in the lakes there were formed vast stores of salt, gypsum, coal and other products. This, which is the most marvelous mineral region known in the world, owes its richness in this respect to its complicated history of folding, faulting, and volcanic eruption. For the present the Rockies seem to have nearly ceased growing, although there are many signs that the growth has not entirely ceased. Within extremely recent times, though not within the history of man, there have been volcanic eruptions, and recently formed lake shore lines have been tilted out of position. As one of the episodes of the Tertiary there was a regrowth of the Sierras and the formation of the Coast Ranges. This seems to have been a part of the great movements which produced the Rockies, but to have been somewhat more recent and, indeed, to be even now in progress of development.

In the Quaternary period one event of great importance occurred, as well as numerous minor changes. The land appears to have fallen and then risen again, and the finishing touches of the present land were made. A narrow coastal addition was made, particularly on the Gulf coast, where the Mississippi embayment was destroyed by the growth of the delta and the uplift of the land. On other parts of this coast low-lying swampy plains were also added.

A series of minor events occurred in the Cordilleras. Volcanic activity continued with constantly decreasing violence, the folding of the mountains approached its close and erosion made extensive breaches in the high mountains. The climate also suffered a change and the interior basin was changed from an arid to a moist region, then again arid and moist, followed by the present condition of aridity. During one of the moist periods great lakes existed in the present interior deserts and overflowed to the sea.

But by far the most important episode of the Quaternary was the oncoming of the glacial period, which followed closely upon the condition of high Tertiary elevation. Extending down to the latitude of New York this ice sheet transformed the northern part of the continent to a great ice plateau analogous to the present Greenland ice cap. How long it stayed and what its exact history has been are points that are still unsettled and under investigation. We know considerable about its effects, and it has been responsible for the great majority of the minor topographic features of the glaciated belt. Our soils and clays, lakes and waterfalls and many interesting bits of scenery are due to this ice invasion, and even the harbors of the New England coast appear to be indirectly a result of the ice period.

To quote the last words of a paragraph upon the same subject in a recent work by the author,* "This is, briefly, and without entering into details or proofs, the general evolution of the continent. Its form was roughly sketched in the very earliest period and it has been slowly perfected, although undoubtedly many changes yet await it. No adequate mention has been made of the effect of erosion during all this time, but this is of prime importance. Old lands have been worn down, and the ruins deposited in the water, to afterward be again built into land and perhaps again transformed into sediment. Erosion and sculpturing have been ever acting, and the present form of the continent is the resultant of the conflict between the two opposing forces; the one tending to build up, the other to tear down."

* "Econmic Geology of the United States."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